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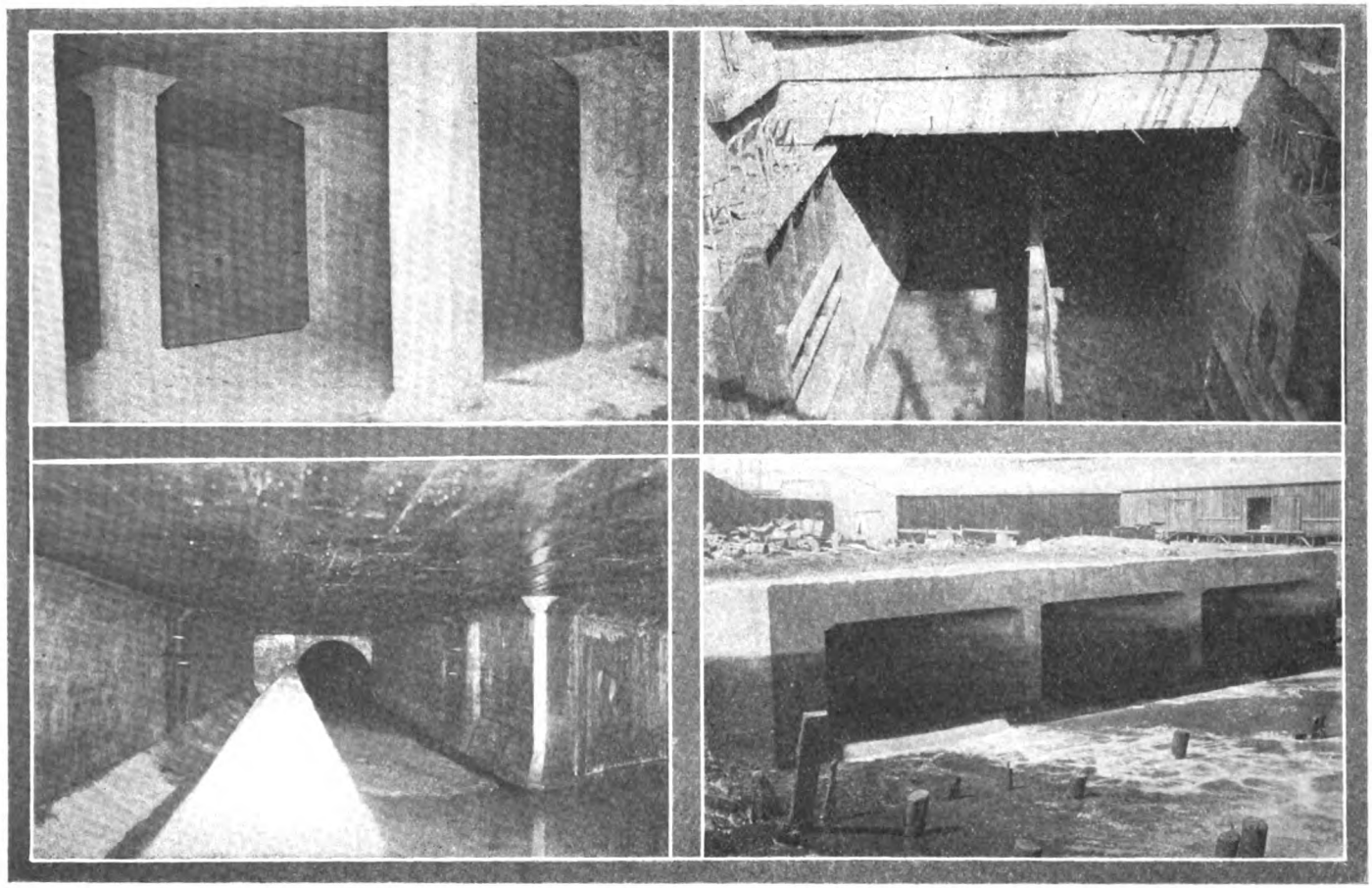

EQUALIZING CHAMBER IN 3-COMPARTMENT REINFORCED CONCRETE SEWER IN DIVISION STREET.

SUMP IN REINFORCED CONCRETE SEWER, SHOWING DIVISION WALL FOR CONFINING FLOW TO EITHER SIDE DURING CLEANING.

OVERFLOW WEIR IN HARRISON STREET AT 14TH STREET.

See page 11.

OUTLET OF 3-COMPARTMENT REINFORCED CONCRETE STORM WATER IN DIVISION AT CHANNEL STREET.

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EDITORIAL

THE President-elect, Mr. Wilson, is in danger of coming into conflict with the trade unions through his abortive efforts at cabinet-making without being fortified with a union card.

WHILE the 'Butter Trust' may be a combination in restraint of trade, and as such deserving of our condemnation, bread and butter is a combination in restraint of hunger that even the high cost of living has not yet been able to dissolve.

DRAINAGE in large cities is hardly less important than is a pure and bountiful water supply. That San Francisco appreciates this fact is shown by the account in this issue of the new sewer system prepared by Mr. A. Judell and Mr. H. W. Shimer. The method by which the project has been handled is comprehensive and thorough, and shows much careful thought and study on the part of the men entrusted with its design and construction. The reduction of the total number of outlets from 125 prior to 1908 to 5 under the plan of the new work, provides a skilful adaptation to the topography of the ground and a minimum outlay for care, inspection, and upkeep.

ELECTRICITY is gaining ground in the oilfields, and Mr. Wishon's article in this number, the first of a series dealing with the application of electricity to pumping and drilling in the oilfields, will be read with peculiar interest in view of the kaleidoscopic changes that are taking place in the control of the large operating companies. Mr. Wishon treats the subject from the standpoint of the distribution of power and answers the questions regarding continuity and readiness to serve that are always asked first when any change in motive power is contemplated. In succeeding numbers, other phases of the subject will be treated by engineers equally well informed. The second article of the series, dealing with the characteristics, use, and care of the electrical apparatus, will appear in the February issue.

ASTONISHING is the frequency with which matters seemingly trivial have the power to change the whole course of human events. Had the discovery not been made that a species of mosquito transmitted the deadly germ of fever, the Panama canal would in all probability never have been built. That the chief difficulty experienced by the French company was due to the high mortality among its employees is shown by the fact that the average number of deaths from all causes among canal employees for nine years of French control was 241 per 1000, while the record for 1911 under American control was only 11. This difference is all the more striking when the Panama death rate of 21.4 per 1000 is compared with cities in the United States where one might expect to find the science of sanitation at its highest point of development. According to the 1910 census, the death rate at Savannah, Georgia, was 26.9; at Charleston, South Carolina, 29.7; Mobile, Alabama, 23.0; Richmond, Virginia, 22.6; Key West, Florida, 22.5; Memphis, Tennessee, 21.4;

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New Orleans, Louisiana, 21.3; and at the seat of the Federal Government, Washington, D. C., 19.6. The splendid achievement of Colonel Gorgas and his assistants is strikingly evident, and the efficiency of military discipline in the execution and enforcement of proper sanitary measures is clearly shown when compared to the laxness of civil government in the administration of municipal affairs.

EFFICIENT unto the day is the press agent thereof. A few weeks ago it was announced through the columns of the daily press that the Natomas Consolidated had contracted with the Oro Electric Corporation for some 20,000 horse-power. The Oro Corporation, although engaged in developing power, has none for sale as yet, and engineers familiar with the power situation have wondered how the Oro Corporation could 'deliver the goods.' The answer is found in the further announcement that the Oro Electric Corporation has closed a contract with the Northern California Power Company for 20,000 horse-power which is to be used by the Natomas Consolidated in its vast reclamation project in the vicinity of Sacramento. In sympathy with this announcement, the stock of the Northern California Power Company, like a good and obedient child, 'went up.' Twenty thousand horse-power is quite an item. As the greater part of it would be day load, it would perceptibly help the load-factor of the power company fortunate enough to get the contract. There are quite a number of power companies serving the district near Sacramento, big ones, too. The rivalry between them is quite keen, and on a contract for 20,000 horse-power the prices would be apt to be scaled down to the last notch. Query: If the price were known at which the Northern California Power Company sold the 20,000 horse-power to the Oro Electric Corporation, who in turn sold it, presumably at a profit, to the Natomas Consolidated at a price that would compete with that offered by other power companies, would the stock of the Northern California Power have responded to the gentle hint and gone up, as per program?

Protecting the Oil Industry

California oil operators are fully alive to the menace of water in the oilfields, as is shown by the activities of the Kern County Oilmen's Protective Association. This Association was organized for the purpose of making a combined effort to combat the evil and to try to save the Kern River field from destruction. Under the guidance of Messrs. Forker and Latham, such beneficial results have been obtained through carefully and systematically cementing wells, that the Association is endeavoring to find a means of extending its activities. The organization as it now stands is a purely voluntary one, the funds for carrying on the work being provided by a comparatively few public-spirited producers within the affected district. As is usual in such cases, there are many producers participating in the benefits derived from the work done by the Association, but who are not contributing anything to its support. Another type of producer, who perhaps is the greatest detriment of all to the industry, is the man who declines to permit the Association to institute protective measures on his property unless he himself is the direct beneficiary. This attitude is fortunately not common, but at the same time cases of this nature have been sufficient in number to make it a matter of prime im-

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portance to bring home to these obstructionists a sense of their obligation to the community. The law of 1909 has proved entirely ineffective in that it provides no adequate penalties, is clumsy, is not specific in its wording, and provides for a commissioner at a rate of pay only about equal to that of a tool dresser. A meeting of the Association was held in San Francisco on December 4 for the purpose of bringing out, through general discussion, the best means of overcoming the present difficulty. Mr. Harry Thomas, of Bakersfield, presided, and after a prolonged discussion it was the sense of the meeting that the general plan for new legislation suggested by Mr. W. F. Sutherland be adopted. Mr. Sutherland's plan, in brief, provides that oil districts be organized along the same lines as provided for the formation of drainage and reclamation districts under the Wright law. A law is to be drafted for submission to the Legislature at the coming session that will fix adequate penalties for infraction of the provisions governing the institution of protective measures, and will confer authority upon the officers of each oil district to enforce the law. Each district, under the proposed law, will be self-supporting; the necessary funds are to be raised on the assessment plan, based upon total production, any unpaid assessments to constitute a lien on the property. The greatest possible latitude is to be permitted each district in the administration of its affairs, as it is recognized that no two districts have to meet precisely the same conditions.

A committee, consisting of Messrs. Sutherland, McLaughlin, Ewing, Sullivan, Storms, Forker, Latham, Minor, Thomas, and Anderson, was appointed to draft the proposed law for submission to each oil producer in order to obtain an expression of opinion that will represent the industry as a whole. Concerted action is absolutely necessary in order that sufficient influence may be brought to bear to secure the needed legislation.

The Harriman Merger Dissolution

Combinations in restraint of trade have suffered another shock. The United States Supreme Court, reversing the decision of the lower court, has decided that the Union Pacific and the Southern Pacific system, prior to the stock purchase that led to the formation of what became known as the 'Harriman merger,' were competitors engaged in interstate commerce acting independently as to a large amount of the carrying trade. Further, since the acquisition of the stock in question, the dominating power of the Union Pacific has suppressed competition between the systems, thereby affecting a combination in restraint of interstate commerce. The court intimates that the Union Pacific may retain the Central Pacific connection between Ogden and San Francisco, thus making a continuous line from the Missouri river to the Pacific Coast and being in competition with the Southern Pacific or Sunset route between San Francisco and New Orleans. The company is ordered to present to the court plans for dissolution within three months. It is unnecessary to report the details of the decision, as the matter has been published in full through the columns of the daily press. It is evident that this decision will be far different in effect from that of the Standard Oil Company, although no difference of any great moment has thus far been apparent in the stock market. The principal question now of para-

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mount interest to the people is, how can the dissolution be effected without damage to the interests of the many small stockholders, and what difference is it going to make to the people whom the roads serve? If an increased degree of controlling and regulating power as exercised by the Government in dealing with great corporations is tending toward Government ownership of public utilities and therefore an enlightened socialism, unrestricted competition goes to the other extreme, and if carried to the limit is absolutely destructive in its effect and little better than anarchy. At the period just before the formation of the Harriman merger, competition between the rival transcontinental lines was keen. Not service competition, but price competition, one result of which was the spending of the least possible amount of money for betterments and upkeep, 'starving the line.' Everyone was complaining. Passenger service was poor, freight service was poor, accidents were not infrequent, and the stockholders got no dividends. Through a stock-market upheaval in which Mr. Harriman played the master part, control of the Southern Pacific passed from the Crocker interests to Mr. Harriman. Whatever may be one's opinion of the methods and tactics employed, there is no doubt that Mr. Harriman was a great constructive genius who employed his administrative ability in bringing order out of chaos and in welding into a homogeneous and harmonious whole the disconnected links of the Southern, Central, and Union Pacific lines and their various branches and subsidiaries. Millions were expended upon betterments, the block system was installed practically throughout the entire system, the passenger service was placed upon a par with that of the most prosperous Eastern roads, and freight was handled upon a schedule with much the same regularity as passenger service. How far the successors to Mr. Harriman will be able to comply with the order of the court and yet preserve for the service of the various communities the efficiency of the organization that has taken so much time, labor, and money to bring to its present high state of development is a question. The men now in charge of affairs are of exceptional ability, and it may be possible that some means of effecting the dissolution may be devised that will preserve all the public benefits of the consolidation and yet free the public from any fear of a general monopoly. It is well recognized that an institution may become too big for maximum efficiency, and it is perhaps significant that the Southern Pacific system was recently divided for operating purposes into five separate units. It is also to be remembered that Mr. Harriman bought the Southern Pacific in order to get the connection from Ogden to San Francisco; the rest was incidental. A return to the old basis of 'competitive' railroading would be a step backward and a detriment to the development of the Western country, but such a result need by no means follow from separation of the two roads. Much criticism has been aimed from time to time at the Sherman law under which the various Government suits against the so-called trusts have been conducted, yet it was enacted in response to a real need, and no suitable substitute has been thus far offered. If the coming Democratic administration develops a constructive rather than a destructive method of dealing with the great aggregations of capital it will earn the gratitude of the nation and prevent disorganization of our industries.

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REVIEW OF THE MONTH

SEASON'S GREETINGS. Another milestone has been passed, leaving a realizing sense of things undone but giving birth to stronger resolutions for a better, a more effective record of accomplishment in the coming year. Human beings are strange creatures. Throughout the greater part of the United States, especially in the large cities, thousands of ordinarily temperate people become possessed with the idea that the old year cannot be decently interred without a preliminary drowning in assorted alcoholic compounds. The origin of this custom is lost in the mazes of antiquity. It is nevertheless more than passing strange that ordinary intelligence takes wings upon this one occasion to give place to an artificially induced jollity born of a desire to paint things red; a color which, filtered through the prism of over-indulgence, fades to dark brown on the morning after.

ALCOHOL, however, in its milder compounds is widely considered beneficial rather than harmful. San Francisco has set the seal of its approval upon this opinion by defeating the local option amendment to the city charter at an election held on December 10. This measure was generally considered to be an attempt to force a 'dry' Exposition, which, in view of the importance of the California wine industry, was an unusual thing to attempt, and was foredoomed to failure. Defeat of the franchise amendments at the same time is greatly to be regretted, and can only be accounted for on the theory that the United Railroads Company is still in such bad odor with the people that the voters considered nothing else in marking their ballots. Mr. Bion J. Arnold made a careful study of the situation with regard to handling the traffic to and from the Exposition, and approved the measure that was submitted. As it now stands, that portion of the street railroad system serving the Exposition grounds is utterly inadequate to carry even a fraction of the number of people that are expected. The measure will have to be brought up again, when it is hoped that the voters may have a clearer understanding of the necessity that prompted its introduction.

ADVOCATES of the Hetch-Hetchy source of water supply for San Francisco have received a temporary set-back. Although the Secretary of the Interior has announced that he would not render a formal decision until additional data concerning alternative sources of supply had been presented, the trend of his thought was clearly indicated by the tenor of his remarks during the course of the hearing. Mr. Fisher voiced the opinion that any source of supply available and already developed was entitled to first consideration from the city. The justice of this cannot be gainsaid. San Francisco should acquire the properties of the Spring Valley Water Company, and has made an earnest attempt to do so. The only stumbling block is failure to reach an agreement as to the price to be paid, and likelihood of doing so thus far seems, unfortunately, somewhat remote. The offer made in Washington

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by the Spring Valley officials to arbitrate the entire question is manifestly fair and should be acted upon promptly by the city. It would be necessary to reserve to the voters the right to reject the award, since they are not likely to agree to the purchase except on the basis of definite figures. In any event, the development of the Hetch-Hetchy water supply, or some other equally good, if there be such, is essential to provide for the future growth of San Francisco. Mr. Fisher has asked that the city engineer prepare further data concerning the McCloud river project. Accordingly, Mr. Loran Hunt, accompanied by a corps of assistants, is now engaged in the preparation of the additional data required by the Secretary. The 'nature lovers,' of whom a goodly delegation was present during the course of the hearing, made but a sorry showing, and were unable to present arguments of any weight in support of their position. The entire project hinges upon the engineering phases of the various possible sources of supply. Those who have gone over the Freeman report will wonder that Mr. Fisher considered it necessary to compile any further data, but he is evidently actuated solely by a desire to consider the project from every possible angle, and will not make his decision until he has given careful study to every detail. The law making the Secretary of the Interior the court of last resort in cases involving the disposal of public lands seems radically defective, in that the grant of a permit by the Secretary carries no surety that it will not be revoked by his successor in office. The Hetch-Hetchy permit was granted by Mr. Garfield while Secretary, revoked by Mr. Ballinger, and now comes before Mr. Fisher. The question should be settled promptly.

GREAT BRITAIN has presented a formal note of protest against that section of the Panama Canal bill which exempts American coastwise shipping from the payment of tolls. As was expected, it is an elaboration of the points of objection contained in the note presented to the State Department last July. Exception is also taken to the clause barring ships owned by railroads from the use of the canal. As was to be expected, the Canadian railroads find this objectionable, as it limits their participation in the benefits to be derived from the construction of the canal and extends the influence of American methods of dealing with common carriers into Canadian territory. The entire controversy may be summed up as a difference of opinion between two nations as to the interpretation of the Hay-Pauncefote treaty. While it is believed that the President would consent to refer the matter to The Hague tribunal, it is doubtful whether the Senate, which must pass upon the recommendation, would consent to this procedure. Great Britain, like a good business man, will advocate arbitration strenuously, as it has everything to gain and nothing to lose by taking such action. One cheerful sign of progress is the fact that even the yellow newspapers have not suggested the possibility of war growing out of the controversy.

LEGISLATION that will embody a definite and comprehensive water-power policy for streams on the public domain, and for navigable streams not on the public domain is recommended by the Secretary of the Interior in his annual report to the President. The report also embodies a recommendation for an enlarged application of the leasing principle as applied to the public

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domain in general, a comprehensive leasing law for coal, oil, and other mineral lands, and a classification of public lands according to their respective characteristic and appropriate uses. Legislation respecting the development of the transportation facilities and coal lands of Alaska is asked for, and the withdrawal from entry of public lands in the West needed to conserve the water supply at the source of streams is recommended. The spectre of the special interests seems a genuine bugaboo to Mr. Fisher, as he fears that the plan now being agitated to turn the control of public lands over to the respective states in which the lands are situated will result in the control by great corporations of all undeveloped national resources of the country through lax administration and inadequacy of state laws, whereas the strong arm of the Federal Government is required to conserve the interests of the people. There is undoubted need for wise, constructive legislation to adjust the entire public lands question on an equitable basis that will permit their development and convert their potential possibilities to the benefit of the people. The indiscriminate withdrawal of vast acreages from entry is hardly less of an evil than dummy locations in the interests of the great corporations. The former permits no development at all, while the latter permits the few to exploit the many and grow excessively rich in the process. The poor prospector has been in receipt of much sentimental consideration, especially during the course of the discussion of Alaska coal land matters, and while he and and his kind are indispensable adjuncts to the body politic, he can neither build railroads, develop mines, nor water power projects. In the reaction that seems to have set in from the pro-capitalistic attitude that existed during the first McKinley administration, the rights and protection of capital seem to be neglected. Capital and labor should go hand in hand, their interests are identical and are not opposed. Another problem for the coming Democratic administration, the solution of which would make us all everlastingly grateful.

ADVANCES in wages have been granted to 30,000 locomotive engineers by the Board of Arbitration, thus settling points of difference between the railroads and their employees that have been pending since January last. Fifty-two railroads operating in the territory east of Chicago and north of Norfolk and Cincinnati are affected. The award is effective from May 1 last and embodies in general the following provisions: In passenger service, a minimum wage was granted of $4.25 for 100 miles or less, and an overtime rate of 50 cents per hour, with an average speed of 20 miles per hour. The engineers asked $4.40 and $4.60 per day of 100 miles, with an overtime rate of 70 cents per hour after five hours. In through freight service, a minimum was granted of $4.75 per day of 100 miles or less, with overtime pro rata after ten hours. The engineers requested rates of $5.25, $5.50, and $5.75 per day of 100 miles and $7 for Mallett engines. In local freight service 25 cents additional to the through freight rates was granted. This met the full request of the engineers. In switching service, a minimum of $4.10 per day of ten hours or less was granted. The engineers asked $4.30 per day of ten hours in switching service and for belt-line service. All existing rates higher than the minimum granted by the board are

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continued in force. The suggestion of the board that federal and state wage commissions be created for the purpose of adjusting all disputes relating to labor employed upon public utilities met with objection on the part of the representatives of labor, on the ground that such a measure would constitute compulsory arbitration. The effect of the award cannot be other than to produce a marked decrease in railroad earnings, and as the Interstate Commerce Commission has shown itself to be firmly opposed to any increase in freight rates, the stockholders of the railroads will undoubtedly soon commence to feel the pinch of the high cost of living. That readjustment of both freight rates and wage scales must be of frequent occurrence as conditions change goes without saying, but both should be based upon the economic value of the service rendered rather than the individual desires of either corporation or trade union for increased pay for the commodity they have for sale. Incidentally, it is interesting to speculate upon what might happen if an arbitration board should order a decrease in a wage scale instead of an increase.

VALUATION of public-service corporations is the latest step taken toward complete governmental supervision over public utilities. A bill has passed the House of Representatives authorizing the Interstate Commerce Commission to make a physical valuation of all common carriers and conduct a complete investigation into their stock and bond issues. This, if it be successful, will mark the adoption of another 'Wisconsin idea' by the nation. Heretofore the only limit to the amount of 'water' in an issue of stock was the capacity of the public to absorb it. There is much difference of opinion as to the proper basis for rate making, but if rates are to be fixed artificially, cost of service may fairly be counted as one factor, even though it can not be considered the only one. Cost of service evidently can not be fixed until cost of plant be determined. Popular valuation of railway stocks has been based only on earning power, and 'unearned increment' has been regularly capitalized. It is apparent that the Government is about to take steps to restrict any increase in the already vast issues of stocks and bonds based upon this factor.

EVIDENCE that California is lagging behind is shown by the United States Geological Survey Report of 1911, covering the production of gasoline from natural gas. This form of the industry is highly developed in the Eastern oilfields. West Virginia has 71 plants, producing 16,694 gallons daily, Ohio has 40 plants, producing 6579 gallons daily. In all, there were, at the close of 1911, 176 plants in the United States, producing 37,000 gallons per day, of which California furnished but one. Since that time, however, California oil-men have shown signs of awakening to the opportunity they have been neglecting. The work of the Honolulu Oil Company, the Purity Gasoline Company, the Pacific Gasoline Company, and the Union Oil Company has blazed the trail for others. The Western Gasoline Company, the Dome Pinal Refining Company, the Puente Company, and several others have taken up the work in earnest, and it is likely that within a few years California will take the commanding position in this branch of the industry that it has already achieved in the production of crude petroleum, and diminish the shortage of gasoline.

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San Francisco Sewer System

By A. JUDELL and H. W. SHIMER*

IN common with the experience of other large cities, San Francisco has found it necessary to reconstruct and re-design its sewer system. As early as the year 1876 the question of the establishment of an adequate sewer system was taken up and the Board of Supervisors at that time instructed the City and County Surveyor to prepare plans for such a system. His report, dated May 22, 1876, points out some of the defects in the system which exist to some extent today, namely, the needless construction of 3 by 5-ft. brick sewers in a large number of streets without regard to the drainage they were to carry, and the intersecting of all sewers, thus allowing the flow to be diverted or split and not confining it to any particular route.

As in a measure accounting for the fact that a large number of the sewers are also too small to properly carry off the storm water, the above report recommends that a maximum rainfall rate of ¼ in. per hour be used in the design of new sewers. This recommendation utterly ignores what is now universally regarded as of prime importance in the problem of sewer design, namely, the time element. In contrast to the practice recommended, this office is now using, in the design of new sewers, a rainfall rate corresponding to a storm of one hour duration, equal to 0.598 in., while for a period of concentration of 5 minutes' time, a rate of 2.16 in. per hour is used.

It is significant, however, that this old report recommended the adoption of Black point as the ultimate outfall point for the major portion of the city's sewage and that this point is in close proximity to the one which has been selected for this purpose in the more recent report of 1899 on a system of sewerage. In endeavoring to utilize the existing sewers, an examination was made for the purpose of ascertaining their condition, which in a large number of cases was found to be very poor. The common brick in brick sewers had worked out where the grade was steep, and the vitrified pipe had also been cut through under similar conditions. A common defect found in brick sewers was the lack of mortar in the brick work. In pipe sewers a lack of mortar in the joints was noted, thus permitting a constant flow of sand from the street, causing settlement of the pavement.

A small amount of cement-pipe sewer was found, ranging in size from 10 to 18 in., and this has invariably gone to pieces. It is necessary to state, however, that the poor work referred to was done many years ago when materials were not as good as they are now. Where filled-in areas overlie old tide and swamp lands, the sewers within the area were generally found, after the earthquake of April 1906, to have been so severely shaken, twisted, and displaced as to be almost useless. Sewers on original ground, however, were not

*Assistant City Engineers.

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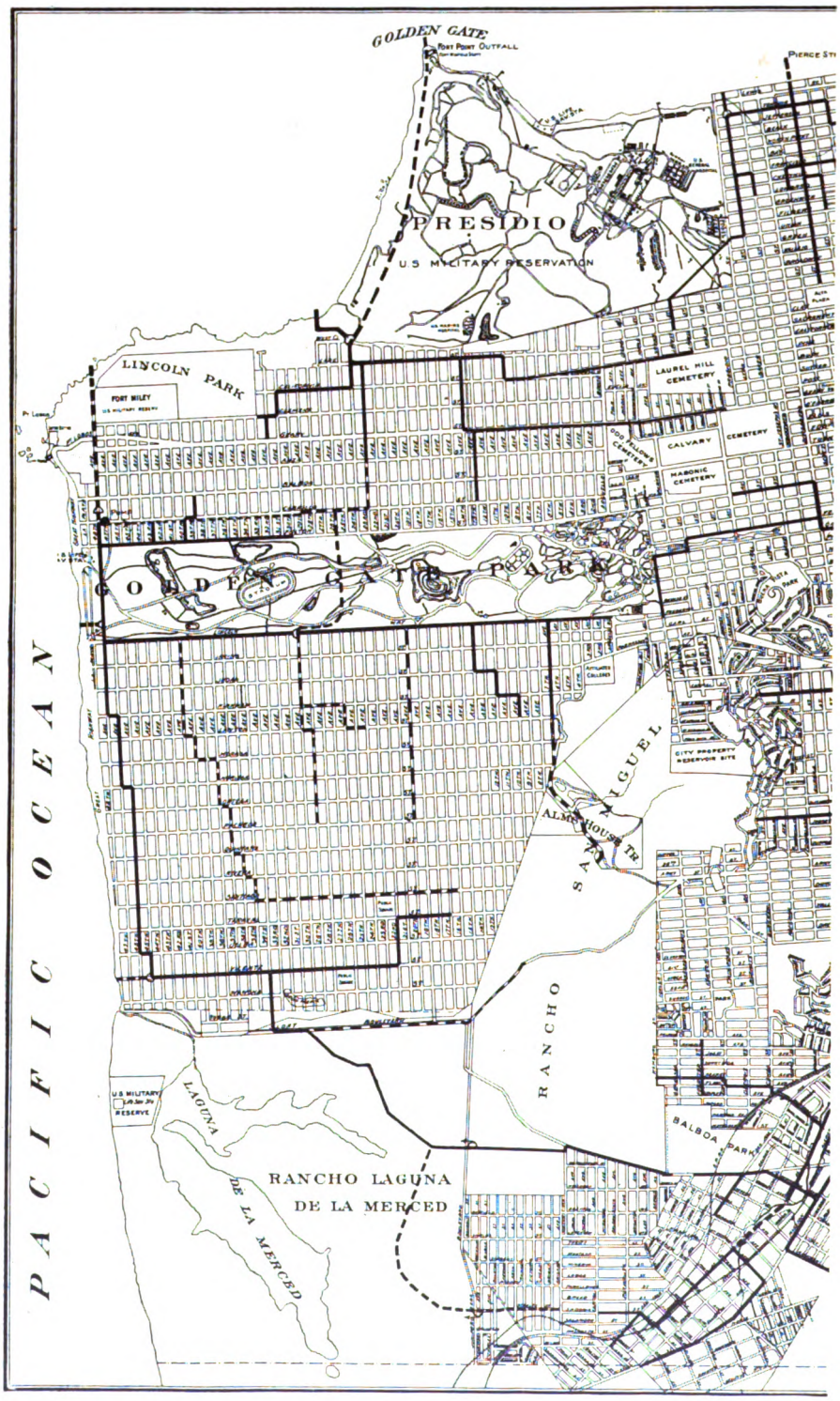

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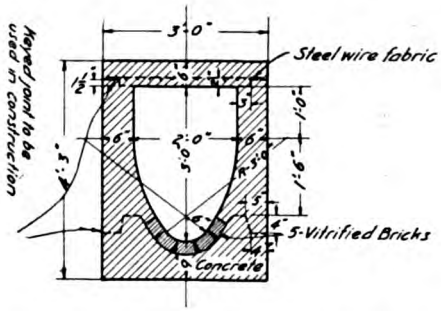
affected by the vibration and shock.

The work now being done in reconstructing the sewer system is being financed by two bond issues. The first issue was for $7,248,000, bearing 3½% interest and voted in 1904. Owing to the low rate of interest, these bonds were found in 1908 to be unsalable and

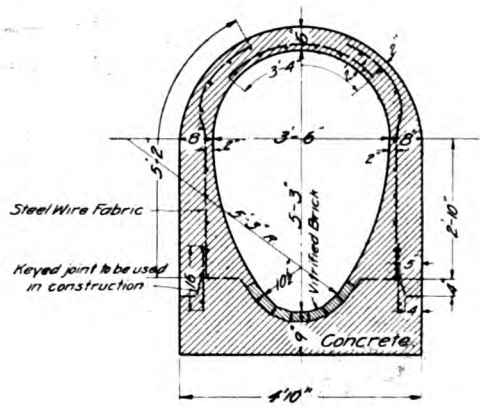


EGG-SHAPED SEWER, 2 BY 3 FT., WITH SQUARE TOP AND A PORTION OF THE INVERT LINED WITH VITRIFIED BRICK.

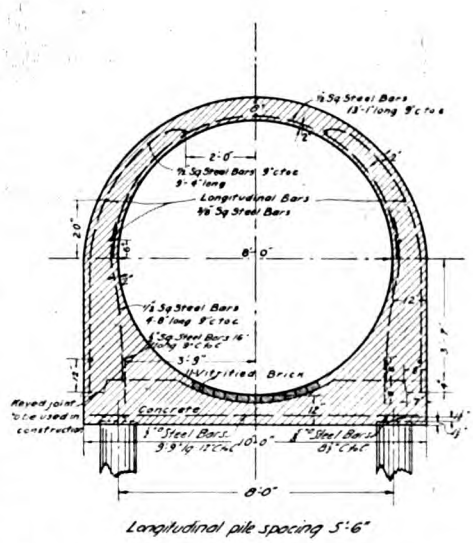
$5,254,800 was canceled. The sum of $1,449,600 had, up to July 1, 1912, been realized and expended in the work, while there remain bonds to the value of $543,600 unsold and uncanceled. In 1908 a new issue of bonds to the amount of $4,000,000 was voted, bearing 5% interest. On July 1, 1912, there had been sold $3,200,000 of this issue, which had brought a total premium of $298,960.36. It is estimated that it will require another issue of bonds to the amount of $4,000,000 to complete the system.

The area of San Francisco, including tide lands, is 30,680 acres (48 square miles) and the peninsula upon which it is built is bounded on the east by the Bay of San Francisco, on the north by the waters of the Golden Gate, and on the west by the Pacific Ocean. In a general way the exterior form may be described as an irregular square with a spur of the Coast Range dividing it into an east and west drainage district. The spur varies from 200 to 900 ft. in height.

Previous to the year 1908 there were in operation along the shores of San Francisco some 125 sewer outlets. Under the plan for the new work these will be reduced to five, discharging house sewage. These will be situated



REINFORCED CONCRETE SEWER, 3 FT. 6 IN. BY 5 FT. 3 IN., PARTLY LINED WITH VITRIFIED BRICK.



8-FT. CIRCULAR SEWER, REINFORCED CONCRETE, PARTLY LINED WITH VITRIFIED BRICK AND SUPPORTED ON PILES.

at China point, Hunters point, North point, foot of Pierce street, and Fort point. The areas ultimately contribut-

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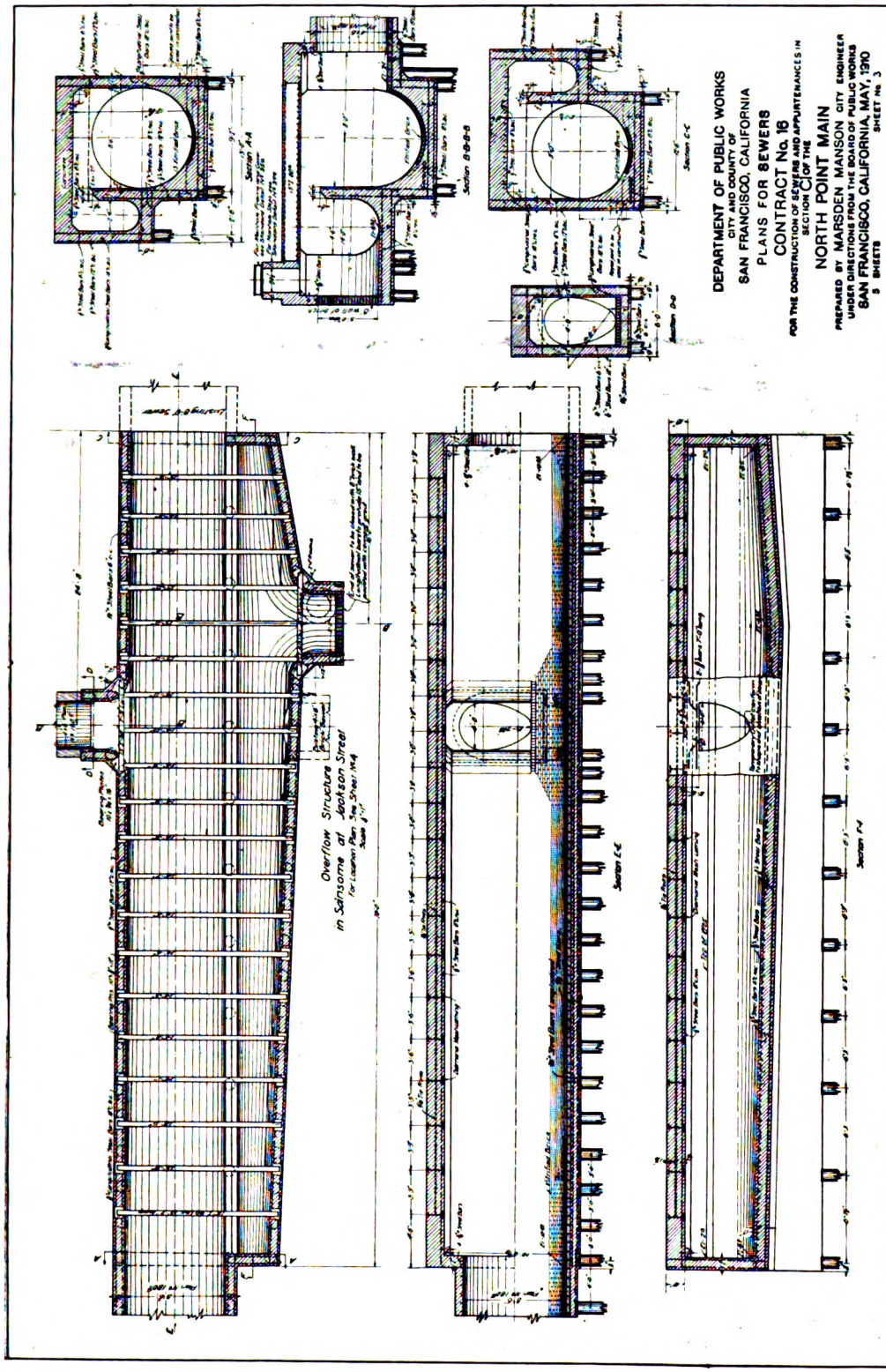

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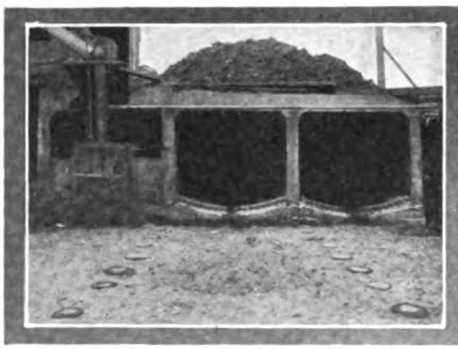
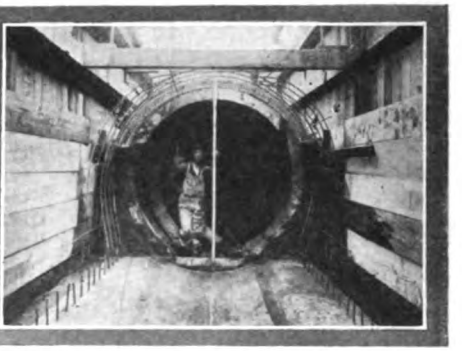
ing house or domestic sewage at each of the outfalls is as follows:

	Acres.
China point	500
Hunters point	2,300
North point	11,525
Foot of Pierce street	800
Fort point	6,919

The last three, on account of the strong tidal currents washing their shores, are considered desirable points to discharge any amount of sewage which is likely to become necessary. The first two are considered safe for limited amounts, which are not likely to be exceeded. Considerable expense has been incurred in building sewers along the Ocean beach with a view to maintaining the beach free from any possibility of pollution. This is being accomplished by the construction of an intercepting sewer which will concentrate the sewage of the lower ocean slope at Forty-eighth avenue and Cabrillo street, where a pumping station is to be constructed and the sewage pumped easterly along Cabrillo street to Twenty-ninth avenue, whence it will flow by gravity to the Fort point outfall. The storm water flow from this district will be carried northward in a tunnel to an outfall near Point Lobos. This tunnel will carry the run-off from all except the very heaviest storms. On such occasions storm water overflows will operate to relieve the sewer. It is estimated that these overflows will not be brought into use oftener than three or four times a year. The estimated quantity to be handled by the pump at Forty-eighth avenue and Cabrillo street is 40 second feet maximum, which will be lifted a distance of 150 feet. This is the estimated sewage from 3877 acres. The total area ultimately contributing sewage to the Fort point outfall is 6919 acres. The Pierce street outfall will serve a district practically all improved at this time, passes through the grounds to be used for the Panama-Pacific International Exposition, and will serve as the main outfall sewer for the Exposition in 1915. The area of this district is 800 acres.



THREE-COMPARTMENT REINFORCED CONCRETE STORM WATER SEWER IN DIVISION STREET, SHOWING PILE FOUNDATION.



7 FT. 6-IN. REINFORCED CONCRETE SEWER IN HARRISON STREET.

By far the largest and most important sewer, however, is the main discharging at North point. The area of the district ultimately to be served by this sewer is 11,525 acres. . Within this area live 80% of the population of the city. It will ultimately receive the discharge from three pumping stations near the

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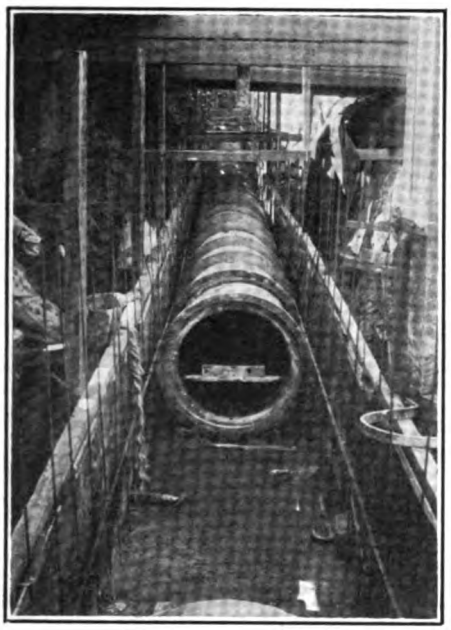
water front. The establishment of a separate system for the low lying districts will permit of draining the basements of buildings without interference from the rising tide. The contract price for the construction of the lower portion of this sewer shown on the accompanying profile aggregates $1,004,743. The Hunters point main and the main discharging at China point serve relatively sparsely settled districts.



24-IN. PIPE SEWER FOR HOUSE SEWAGE ONLY, EMBEDDED IN REINFORCED CONCRETE AND SUPPORTED ON PILES ON NINTH STREET FROM HARRISON TO DIVISION STREETS.

The most important storm water relief outlet is the Division street outlet, running from the North point main on Harrison street to an outlet in Channel street, a navigable waterway 200 ft. wide. This sewer in its lower portion consists of three compartments, each 8 by 9 ft. and has a capacity of 1800 second feet at high tide. All sewers are designed to carry their maximum calculated flow at extreme high tide (elevation 4 ft. below city base) and the overflow weirs are designed to retain the calculated maximum dry weather flow at ordinary high tide (elevation 5 ft. below city base). This permits a depth of flow 1 ft. over the weirs. The length of the various overflow weirs run from 10 to 100 feet.

In the design of all new sewers, preference has been shown for reinforced concrete and double strength vitrified clay pipe. The pipe has been used for sewers up to 30 inches in diameter. The smallest concrete sewer used is 2 by 3 ft. with a slab top and egg-shaped invert. Egg-shaped inverts and arched tops are used from 3 by 4 to 4 by 6 ft. Larger sewers are circular or horseshoe shaped. Where any scouring action is anticipated, vitrified brick is used in the invert. It was realized that one of the essentials in a good sewerage system is a true invert gradient and to this end particular attention was paid to securing permanent foundations. Piles were driven in the low, filled-in areas, some as long as 80 ft., while at other points the sides of the sewer were reinforced to enable it to span between concrete piers or trestle bents.

The engineering organization in charge has been particularly successful in securing a uniformly high class of work and the character of the work has received favorable comment from various civic organizations in the city. The average breaking stress on test cylinders of concrete 6 in. diameter and 10 in. long is 1200 lb. per square inch. Cost data have been kept on the entire work and as an example the following represents the cost of a portion of the North point main sewer:

Eight-foot circular reinforced concrete sewer in Howard street between Second and Fourth streets, average

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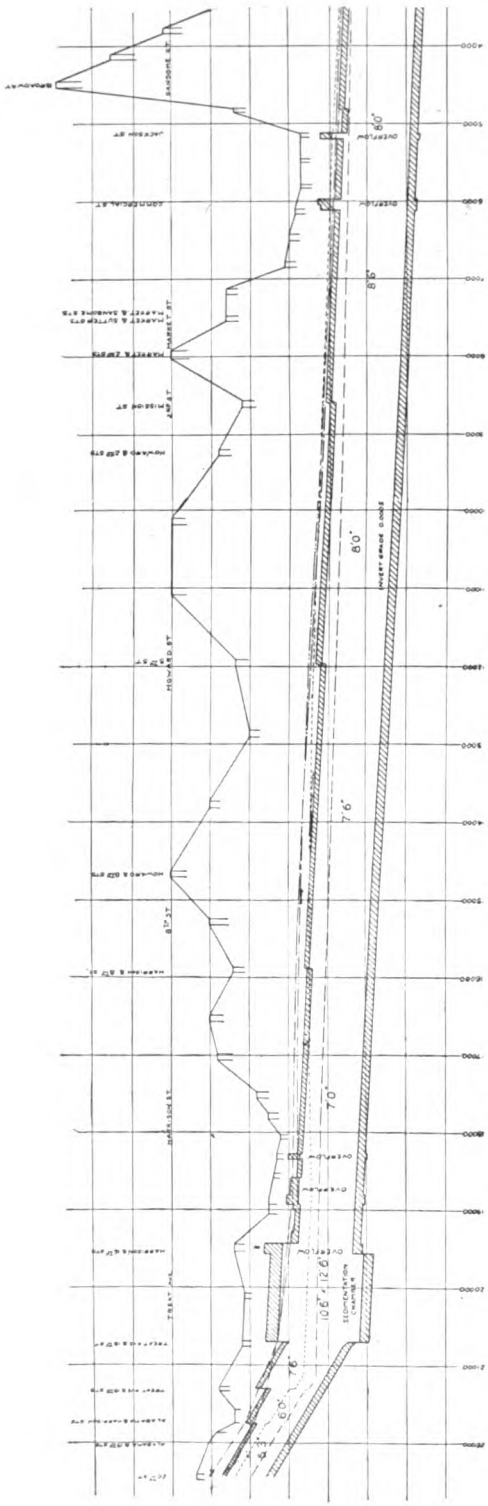
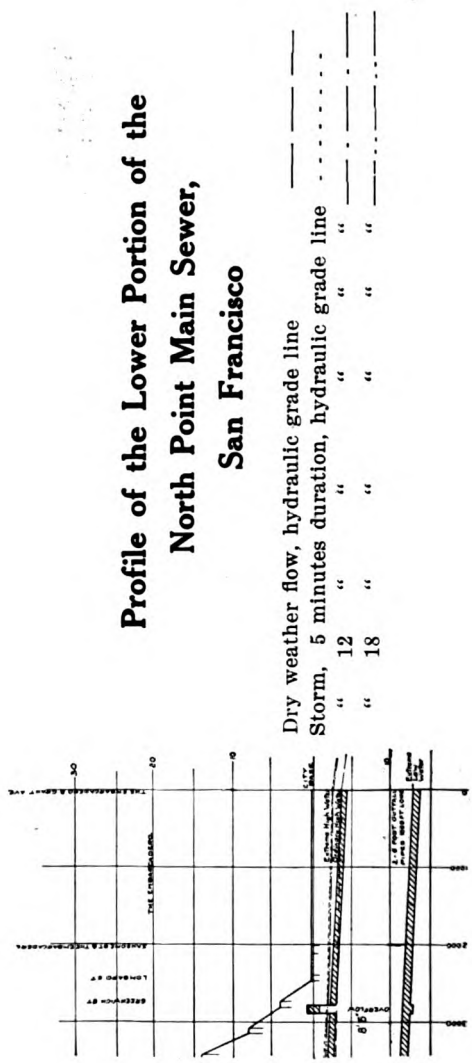


depth 25 feet. Pavement, basalt blocks on sand and double electric car tracks. Street was left open to vehicle traffic:

	per lin. ft.	
Excavation	$7.86	$0.618 per cu. yd.
Lagging	6.45	0.106 per sq. ft.
Forms	1.765	0.070 per sq. ft.
Steel	1.48	0.028 per lb.
Concrete	6.915	5.31 per cu. yd.
Brick lining.....	0.691	0.046 per brick.
Finishing	0.348	0.014 per sq. ft.
Backfill	2.02	0.202 per cu. yd.
Miscellaneous ...	0.567	
	$28.096	

The accompanying tabulated statement represents the labor costs on an $86,600 contract in an outlying district.



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Contract No 28 Bay View Sewer Aug 1909 - July 1910
Contra Costa Construction Co

Class of Construction	Quan per lin ft	Hours of labor per unit Quantity: Foreman	Carpenter	Mason	Teamster	Hostler	Driver	Common Labor	Teams	Cost per lin ft	Cost per unit Q	Remarks
5'6" Circular Reinforced Concrete Sewer 24th Ave. Railroad Ave to K St 633 lineal ft Total Labor Cost per lin ft $5.86												
Superintendence lin ft										$.437	$ .31	Plastic sand and clay 8 deep with scrapers 4 by hand 4410 cu yd Av depth 18'
Excavation cu yd	7.0	.072			.102			.622	1.13	2.15	.048	4 M 2x8 lagging used Twice 1.35 lin ft of Trench 4100 sq ft
Lagging 100 sq ft	6.3	.4						.084		.30		
Forms lin ft		.178	2.27							.84		10 Forms made used 10 Times included outside forms
Concrete cu yd	.742	2.35						2.75		.72	.985	470 cu yds Concrete
Brick lining M	2.6			10.7		10.7		3.52		2.1	8.05	17750 Brick used
Steel 100 lbs	31.3							4.45		4.31	1.39	19850 lbs Steel
Painting 100 sq ft	11.75							1.257		.05	.43	1800 sq ft Painted
Cleaning lin ft								.142		.043		
Back fill cu yd	.27	.026						.370		.33	.123	1700 cu yds
Embankment cu yd	2.4	.037			.117			.057		.35	.147	1500 cu yds
4'6" Reinforced Concrete Sewer 20th Ave S & J St to 16th Ave S & F St S 366 lin ft Total cost per lin ft $5.26												
Superintendence lin ft										.39		Material sand except 200' soft rock 6000 cu yds.
Excavation cu yd		.02			.036			2.63	.03	1.49	.90	2332' 0 to 5' deep 860' 5' to 10' 160' 10 to 15' 215' 15 to 22'
Lagging 100 sq ft		.469						6.61		.21	2.44	32000 sq ft
Forms lin ft		.065	1.2							.59		40 inside forms made & moved 15 times 2335 lin ft outside forms
Concrete cu yd	0.67	.888						2.89		.72	1.08	2460 cu yds concrete
Brick lining M	2.5			7.46		7.46		3.24		.17	6.55	32700 Brick
Steel 100 lbs	30.6							2.21		.20	.65	112,210 lbs Steel
Cleaning lin ft								.153		.048		
Painting 100 sq ft	12							1.215		.063	.44	43800 sq ft
Back fill cu yd	1.29	.028			.070			.244	.085	.19	.145	.4725 cu yd
Embankment cu yd	2.88	.064			.449			.258	.441	1.20	41.5	1055 cu yd haul 3000 ft Material borrowed, loosened by 4 H Plow & scraped with Fresno into wagons
3'6" x 5'3" Reinforced Concrete Sewer 21st Ave S & K St S to 20th Ave S & J St S 917 lin ft Total cost per lin ft $5.54												
Superintendence lin ft										.405		
Excavation cu yd	3.05	.174						2.5	.107	2.62	.86	2800 cu yd Trench 7' to 22' deep
Lagging 100 sq ft	10.9	.262						10.9		.52	.048	10,000 sq ft
Forms lin ft		.113	1.26							.48		
Concrete cu yd	0.6	.284						3.92		.79	1.32	550 cu yds Concrete
Brick lining M	2.5			8.5		8.5		3.74		.17	6.65	22750 Brick
Reinforcement 100 sq ft	1.27							1.77		.103	.55	17100 sq ft Wire fabric
Cleaning lin ft								.174		.046		
Painting 100 sq ft	10							1.44		.049	0.49	9170 sq ft
Back fill cu yd	2	.04			.084			.475	.024	.36	0.18	1840 cu yd
2'6" x 3'-9" Reinforced Concrete Sewer 22nd Ave S & K St to 21st Ave S & K St S 252 lin ft. Total Cost per lin ft $4.65												
Superintendence lin ft										0.864		
Excavation cu yd	2.6 cu	0.300						3.050	0.180	2.72	1.05	651 cu yds. Sand 7' to 23' depth of Trench
Lagging 100 sq ft	4.2 sf	3.700						11.300		0.196	0.049	1000 sq ft
Forms lin ft			0.695							0.232		Forms borrowed & repaired
Concrete cu yd	0.49 cu	0.310						4.070		0.69	1.420	123 cu yds
Brick Lining M	17			8.290		8.290		3.680		0.11	6.43	4350 Brick
Reinforcement 100 sq ft	4.5 f							3.088		0.086	0.90	1000 sq ft Fabric
Cleaning lin ft												
Painting 100 sq ft	9.1 f							0.815		0.048	0.49	2450 sq ft
Back fill cu yd	1.8 cu		0.017					0.475		0.275	0.151	460 cu yds
Taper Connection 5'-6" to 7'-3" 24th Ave. S & Railroad Ave. Total Labor Cost = $141.05 Len = 10'												
Superintendence										$.040		
Excavation cu yd								2.600			$0.78	45 cu yds. Sand 15' deep
Lagging cu yd								1.111			0.33	
Forms M				40.00				194.00			80.50	500 F B M Lumber
Concrete cu yd			1.000					5.450			2.12	9 cu yds haul 200 ft
Brick Lining M				23.3							9.16	300 Brick
Steel 100 lbs								5.310			1.67	375 lbs Steel
Back-fill cu yd								1.333			0.40	30 cu yds.
Taper Connection 3'6" x 5'-3" to 4'-6" J St S. & 20th Ave S Total Labor Cost = $135.00												
Superintendence										$.000		
Excavation cu yds		0.333						4.260			$1.50	45 cu yds 22' deep
Lagging cu yds								0.666			0.22	
Forms M			57.50					112.54			62.50	400 F B M Lumber
Concrete cu yd		0.715						5.290			2.10	7 cu yds
Brick Lining M				17.790							7.79	22.5 Brick
Steel 100 lbs								2.615			0.74	306 lbs
Back-fill cu yds								0.457			0.13	3.5 cu yds
Piles Total Labor per ft of Penetration = $0.099												
Driving ft of pen		0.058	0.018					0.043			0.064	
Hauling Piles								0.022	0.017		0.017	
Moving Driver		0.038	0.006					0.025	0.023		0.018	

Contract No 28 Bay View Sewer Aug 1909 - July 1910
Contra Costa Construction Co

Class of Construction	Quan per lin ft	Hours of labor per unit Quantity: Foreman	Carpenter	Mason	Teamster	Hostler	Driver	Common Labor	Teams	Cost per lin ft	Cost per unit Q	7 to 21st Ave S
Taper Connection 2'-6" x 3'-9" to 3'-6" x 5'3" K St S. & 21st Ave S Total Labor Cost = $101.00												
Excavation cu yd		0.175						2.400			$0.84	40 cu yds 23' cut
Lagging cu yd								0.025			0.13	
Forms M			100.00					128.50			76.66	300 F B M Lumber
Concrete cu yd		0.416						6.360			2.14	4.8 cu yds
Brick Lining M				20.00							8.75	200 Brick
Reinforcement 100 sf								2.000			0.67	150 sq ft Fabric
Back-fill cu yd		0.047						0.375			0.13	32 cu yds
Taper Connection 2'-4" x 3'-6" to 2'-6" x 3'-9" K St S & 22nd Ave. Total Labor Cost = $21.00												
Excavation cu yd								1.365			$0.41	11 cu yds
Forms								8.000			2.50	
Concrete cu yd		0.375						7.500			2.44	4 cu yds
Brick Lining M				22.80							20.00	175 Brick
Reinforcement 100 sf								1.390			3.75	36 sq ft
Back fill cu yd								0.500			0.14	4 cu yds
Underdrains		3667 lin ft 6" Pipe						1767 lin ft 8" Pipe				
lin ft								0.172		0.063	0.063	1 yd Rock per 40' Pipe. 1 sack Cement per 20 joints

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Contract No 28 Bay View Sewer Aug 1909 - July 1910
Contra Costa Construction Co

Class of Construction	Qty	Hours of Labor per Unit Quantity							Cost		Remarks
		Foreman	Skilled Labor	Helper	Teamster	Team	Common Labor	Team	per Unit	Total	
2'-4" x 3'-6" Reinforced Concrete Sewer 24th & Railroad Ave to 22nd Ave S & K St S											
1131 lin ft Total Cost per lin ft $3.95											
Superintendence lin ft									$.292		
Excavation cu yd	1.30 cy	0.231					3.370	0.108	1.45	$1.16	Sand 1480 cu yd 980 cu yds Trench 8' to 22' 580 cu yds Trench 0 to 8 deep
Lagging	100.34 ft	5.31 f	3.333				10.000		0.242	0.046	30 M Lumber 6000 sq ft lagging
Forms	lin ft		0.021	0.995					0.313		4 Formsmade & 20 borrowed 400 lin ft outside forms 16 M Lumber
Concrete	cu yd	0.46 cy	0.365				4.370		0.558	1.41	450 cu yds
Brick Lining	M	15			1.440		1.440	3.520	0.153	1.042	16 750 Brick
Reinforcement	100 sq ft	3.51 f						2.780	0.029	0.83	4000 sq ft Fabric
Cleaning	lin ft							0.58	0.047		
Painting	100 sq ft	9.5 f						1.095	0.047	0.528	10 300 sq ft
Back Fill	cu yds	1.0 cy	0.046			0.086		0.841	0.086	0.258	11.20 cu yds
Embankment	cu yds	1.40 cy	0.038			0.371		0.371	0.371	0.56	1615 cu yds 500 yds hauled 2500 ft Remainder borrowed Wagons loaded w th scraper haul 2500 ft
21" I S Pipe L St S 23rd to 24th Ave S 328 lin ft Labor Cost per lin ft = $1.50											
Superintendence lin ft									$.011		
Excavation cu yd	1.28 cy	0.419					2.290		1.04	$0.81	Sand Are Cut 9' 420 cu yds
Lagging lin ft							0.134		0.042		
Pipe Laying lin ft				0.271			0.271		0.178		
Back Fill cu yd							0.322	0.061	0.125	0.10	410 cu yds
Over-Flow Structure 24th Ave S & Railroad Ave Total Labor Cost = $260.85											
Superintendence									$16.25		
Excavation cu yd		0.417					7.00			$0.75	120 cu yds
Forms M			26.00				16.00			63.25	1000 F B M Lumber
Concrete cu yd		0.333					3.79			1.35	2.4 cu yd
Brick Lining M				9.620		9.620				7.38	1.00 lf Brick 100 Red Brick bulkhead
Reinforcement 100 lbs							14.75			5.20	950 lb Steel ½" bent & placed
Back Fill cu yd							2.22			0.069	45 cu yds

Development of Seattle Harbor

By PAUL P. WHITHAM*

HARBOR improvement work is a live question in every seaport up and down the Pacific coast today; so much so that many of the largest engineering projects, under way or proposed, have to do with the construction of port facilities. Seattle is by no means an exception to the rule in this respect, as is evidenced by the fact that it has organized a port district and elected three commissioners to direct port affairs. The Port Commission, while it has been in existence less than a year, has prepared and adopted a comprehensive plan for the improvement of the harbor, and has obtained authority to spend $8,100,000 in the construction of docks and other shipping facilities. The purpose of this article is to describe the proposed improvements, together with work being done by other local agencies and by the United States Government. Preparatory to taking up the various projects in detail, it may be well to describe briefly the topographic and other general features of the situation.

Referring to the key map, Lake Washington is separated from Puget Sound by hills and ridges varying from 150 to 500 ft. in elevation. There are two gaps in this barrier, however; one in line with Salmon bay and Lake Union, through to Union bay, an arm of Lake Washington, and the other the Duwamish and Black River valleys, connecting with Lake Washington at the south end.

An advantageous feature in regard to Seattle's hilly location lies in the fact that the ridges are cut through by valleys or divided by the water-level gaps just described, so that it is possible to connect the various sections of the city by trunk highways with low gradients. These topographical conditions deter-

*Acting Chief Engineer, Port of Seattle.

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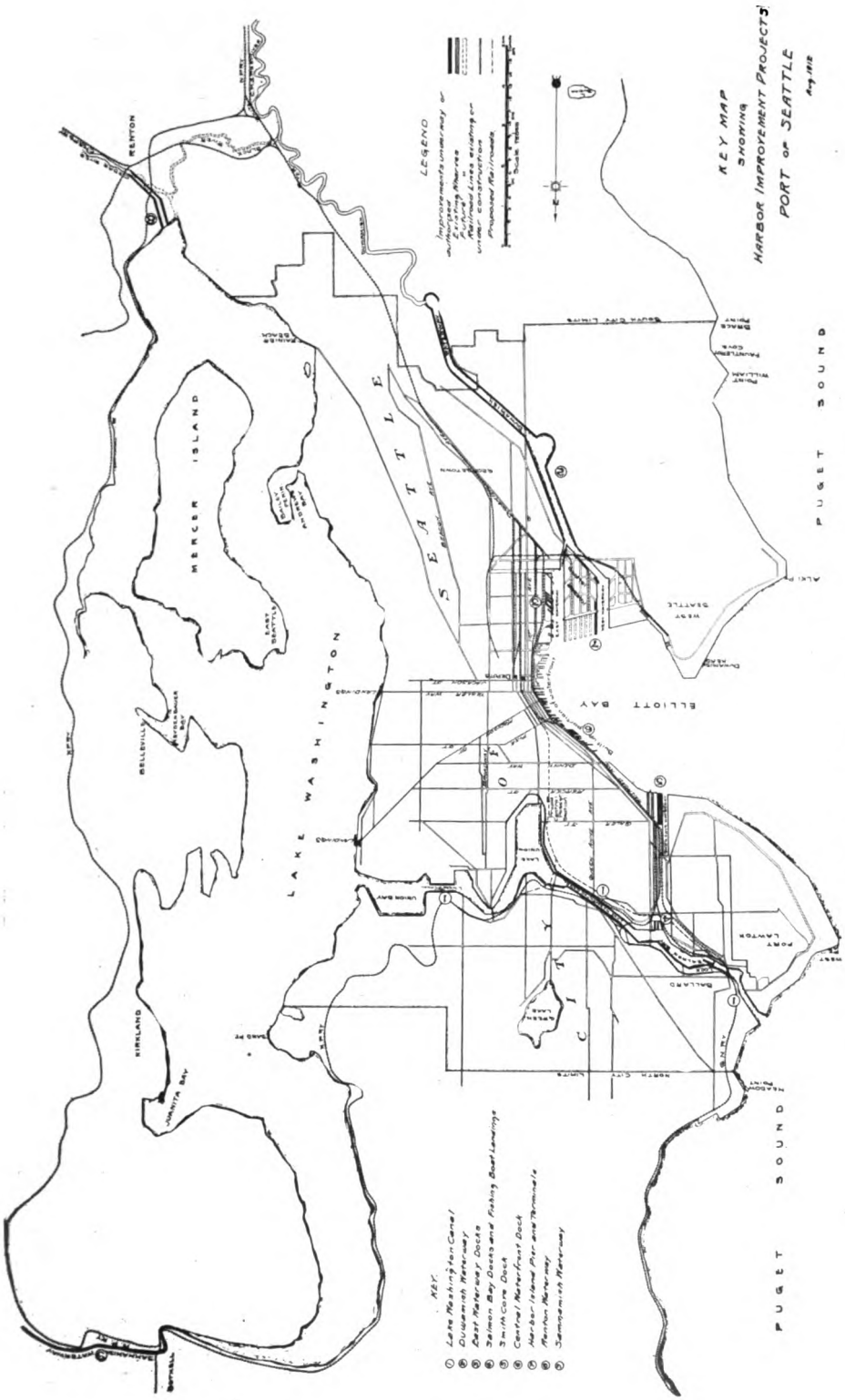

SEATTLE HARBOR, SHOWING POSITION OF PROJECTED IMPROVEMENTS.

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mine the lines of railroad approach, which are as indicated on the key map. The property suitable for shipping and industrial purposes is, for the most part, situated adjacent to the waterfront or along the railroad lines. As shown on the key map, the various projects for the improvement of the Port of Seattle are as follows.

By the U. S. Government, assisted with funds raised locally:

(1) Lake Washington canal.

By Commissioners of the various local improvement districts:

(2) Duwamish waterway.

(8) Renton waterway.

(9) Sammamish waterway.

By the Port of Seattle Commission:

(3) Wharves, sheds, warehouses, etc., East Waterway project.

(4) Wharves, warehouses, etc., devoted to the fishing fleet; Salmon bay project.

(5) Wharves, sheds, warehouses, etc., Smith's cove project.

(6) Wharves, sheds, warehouses, etc., Central waterfront project.

(7) Wharves, sheds, warehouses, and complete terminal facilities; Harbor island terminal project.

(1) **Lake Washington Canal.**—As the elevation of Lake Union is approximately 8 ft. and Lake Washington approximately 16 ft. above sea-level, it has long been considered feasible and desirable that the two lakes be connected with Puget Sound, thus making available large fresh-water basins with natural depth of water sufficient to float the largest vessels. Nature, by placing Salmon bay and Lake Union in close proximity, nearly provided the canal, and what was left undone is now being completed under the direction of the United States Engineers' Department, by funds contributed jointly by the United States Government and by King county. The locks are being constructed at the narrow entrance to Salmon bay and are two in number, placed side by side. The large lock is 80 by 825 ft. inside dimensions, and the small lock is 30 by 125 ft. inside dimensions. Upon the completion of the lock, Salmon bay will be raised to the level of Lake Union and connected therewith by a canal. The two lakes will be connected by a canal, and the level of Lake Washington will be lowered to that of Lake Union. Thus will be created a non-tidal, fresh-water harbor, with a shore line of approximately 100 miles. For this work $3,275,000 has been authorized.

(2) **Duwamish Waterway.** — In the wide valley of the Duwamish river, extending southward from Elliott bay, is a large area particularly well suited for industrial development. The Duwamish river in its natural condition would be a hindrance rather than an aid to this development, on account of its winding course, the river swinging back and forth from one side of the valley to the other. It is now proposed to straighten the river for some four miles of its length, forming the Duwamish waterway. It will be a channel 500 ft. in width which, in the beginning, will be excavated to a depth of 16 ft. at low tide, with a width of 150 ft. on the bottom. Later it will be widened and deepened, as the needs of commerce require. The waterway will be flanked on either side by a marginal way, on which will be placed joint-user railway tracks, from which the various industries may be served by railway spurs. Factories along the Duwamish waterway, therefore, will have the advantage of being well served by water and rail transportation facilities. The Duwamish Waterway Commissioners have acquired the right-of-way, and are about

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to open bids for construction; $1,600,000 is available for the improvement.

(8) **Renton Waterway.**—At the south end of Lake Washington, Cedar river flows almost into the lake, but turns and reaches the Sound through the Duwamish valley. A channel known as the Renton waterway, about a mile in length, is now being excavated for the dual purpose of diverting the river into Lake Washington, and of giving shipping access to the industrial town of Renton, within the limits of which are several coal mines and a number of manufacturing plants depending thereon. For this improvement $100,000 was authorized, and work is now well under way.

(9) **Sammamish Waterway.**—Lake Sammamish, which is not shown on the key map, but lies a few miles east of the north end of Lake Washington, is drained into the latter. Recently the valley connecting the two was improved by a drainage channel, which, it is contemplated, will later be widened, deepened, and equipped with locks so that smaller boats and barges can be utilized for bringing products of the coal mines and farming localities about Lake Sammamish to the Seattle markets; $50,000 was expended on this improvement.

Improvements to Be Made by the Port of Seattle.—As outlined, the Port of Seattle Commission has authorized, and is now preparing to get under way, six improvement projects. While it might be of interest to go into the detailed plans for these various improvements, they have not been sufficiently perfected to justify their presentation at this time. For that reason it is intended in this article to describe only the general features of each layout.

(3) **East Waterway Project.**—One of the first two improvements to be started will be the East waterway project, bids for which are now being taken. The general purpose of this improvement is to provide dockage for sea-going vessels. The plan provides for dredging a slip 212 ft. in width and 703 ft. in length, extending eastward from East waterway to Whatcom avenue. On each side thereof, timber wharves and sheds are to be constructed. The sheds are to be 90 ft. in width with two depressed tracks in the rear. The wharf aprons on the slip side will be 24 ft. 7½ in. wide, and will support one railroad track for direct ship and rail transfer. The design is such that traveling freight conveyors or towers may be operated along the face of the wharves. The sides of the slips, which will slope backward under the wharves, will be protected with rock rip-rap.

The initial improvement will provide facilities as follows:

Shed area, square feet	171,826
Dock frontage (deep sea), lineal feet	1,406
Dock frontage (local), lineal feet	600
Estimated cost of East waterway improvement, including land to be acquired and providing a safe margin for contingencies	$850,000

(4) **Salmon Bay Project.**—The general purpose of this improvement is to provide dockage facilities for sea-going vessels, together with landings for fishing and other local boats. The plan for the improvement of the property at the south side of Salmon bay provides for two slips with a central pier 980 ft. in length. Untreated timber may be used advantageously in substructure work at Salmon bay, thus materially reducing the cost, on account of the fact that the completion of the lock now under construction by the United States Government will result in providing fresh water at a constant level. The initial improvement contemplates the construction of a fishing boat terminal. In and along the sides of the easterly slip,

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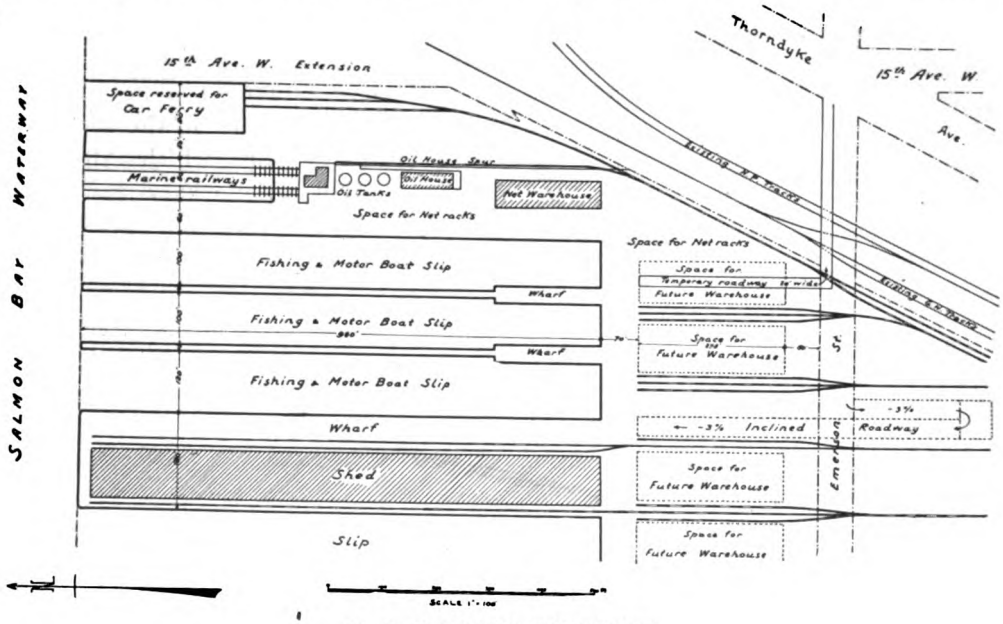
floats and facilities for fishing and other motor boats will be provided. There are to be two lines of log floats, 8 ft. wide, with a combined length of 1820 feet.

A marine railway, together with storage ways for laying up small boats, net racks, also a warehouse for nets and fishing equipment will be provided. Railway tracks and small push-cars, similar to those used in mines or industrial plants, are to be provided for use in transporting nets and equipment.



PLAN OF SALMON BAY PROJECT.

Salmon bay is at present much used by mill companies for the storage of logs. There will be considerable space reserved for such purposes for the time being. After the completion of the lock the space will be available as an anchorage ground for motor boats. The property will be served by railroad tracks leading from the proposed common-user tracks that will connect with the various railroad companies in the Interbay district, and with the port improvements at Smith's cove. The result of this will be to make the Interbay district with dock frontage at both north and south ends practically one terminal unit, accessible to all the transportation lines entering the city.

The initial improvement will provide landings as follows:

Float and wharf frontage, lineal feet	3,055
Estimated cost of Salmon bay improvement, including land to be acquired and providing a safe margin for other contingencies.....	$350,000

(5) **Smith's Cove Project.**—The general purpose of this improvement is to provide a transhipping terminal equipped to take care of the largest sea-going vessels and to handle lumber shipments as well as general cargo. The plan for the improvement of the property provides for a double pier, that is, a pier of double width with a warehouse or shed on each side, approximately one-half a mile in length and 310 ft. in width. Two merchandise sheds, each 680 ft. in length, with a combined area of 149,220 sq. ft., are erected at the outer or southern end of

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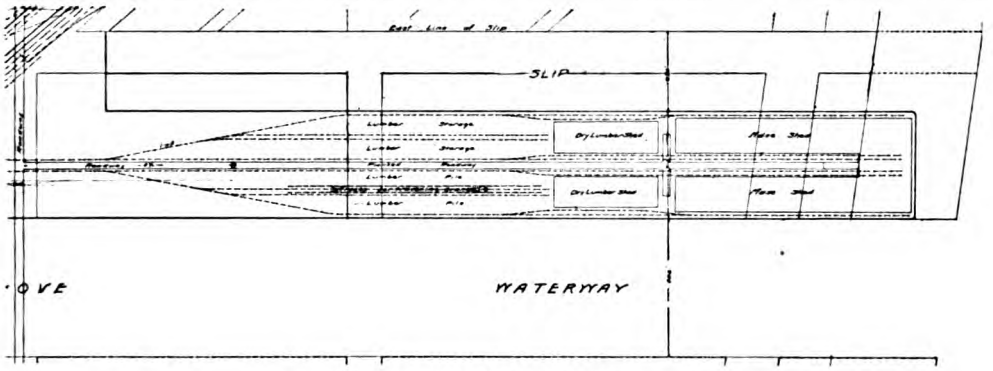
the pier. Immediately north of the merchandise sheds are two dry-lumber sheds with a combined area of 54,000 square feet. The space between the lumber sheds and Garfield street, the northerly limit of the property, is reserved for lumber yards, to be equipped with the most modern lumber storage and handling devices. Adequate railroad trackage is planned for the entire pier, and a driveway will connect with the Garfield street viaduct.

The plans provide for filling the central portion of the pier, which fill will be retained by proper bulkheads and slopes. The supporting wharf and foundation plans for the sheds contemplate concrete construction, but the apron, which can be readily renewed, may be built on creosoted piling. The question of creosoted piling or concrete shed sub-structures is not yet fully settled, however.

The initial improvement will provide facilities as follows:

Total shed area, square feet.....	203,222
Total dock frontage, deep-sea shipping, lineal feet.....	3,950
Total dock frontage, coastwise and local, lineal feet.....	600
Estimated cost of Smith's cove improvement, including land to be acquired and providing a safe margin for contingencies.....	$1,000,000

(6) **Central Water Front Project.**—The general purpose of this improvement is to provide landing facilities for the local and coastwise freight and passenger steamers, including smaller vessels, such as motor boats. The plans for this improvement have not been sufficiently developed to enable an illustration to be shown. It may be stated, however, that on account of its location and the topography of the land back of it, the improvement will be rather unique in arrangement and outline. It is proposed to provide approximately 780 ft. of quay frontage on the west or bay side of the improvement, and 400 ft. on the south side. On the north side will be formed a protected basin in which it is proposed to place a floating landing-stage about 50 ft. in width by 250 ft. in length. In addition, floats will be provided for the smaller launches. It is proposed to utilize the landing-stage for the accommodation of the motor-propelled passenger boats and launches engaged in the summer and suburban business. The average tide being 12 ft., such a stage should prove a great convenience to these small craft.



PLAN OF SMITH'S COVE PROJECT.

Two-story freight sheds are to be erected on all three sides of the improvement. The central portion will be filled, and thereon is to be erected a fire-proof cold-storage warehouse, probably five stories in height, for which a

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ground-floor area of approximately an acre will be available. The improvement is in close proximity to the public market and the up-town district. For that reason it is proposed to make it the water-gate to the retail district, and to operate it in close conjunction with the public market, so that farm products arriving by water may be placed either in cold storage or delivered at the market with little delay. A great deal of attention will be given the arrangement for handling this class of business, with a view to obtaining greater speed and economy. It is proposed to construct a roof garden or recreation pier on top of the cold-storage building, from which a splendid view of the harbor may be obtained.

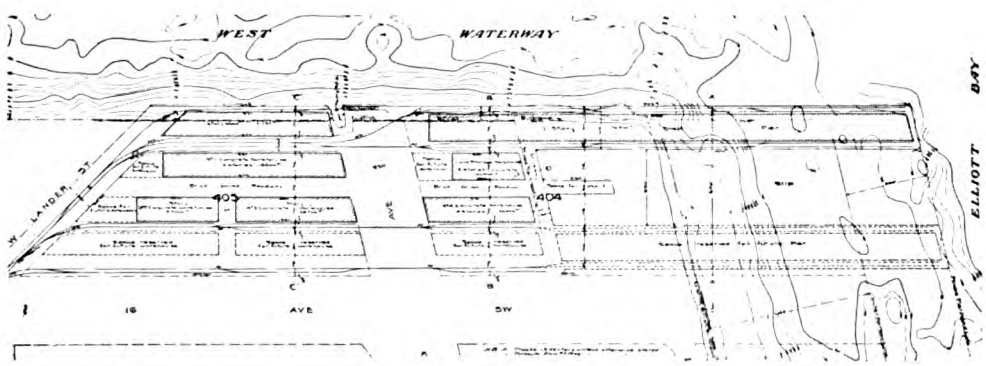
The initial improvement will provide facilities as follows:

Dock frontage for coastwise and Sound steamers, lineal feet.....	1,165
Landings for motors and other small boats, lineal feet	810
Shed area, counting two floors, square feet	65,000
Estimated cost of Central waterfront improvement, including land to be acquired and providing a safe margin for contingencies.....	$750,000

(7) **Harbor Island Project.**—The general intent of this improvement is to provide a harbor terminal especially designed to care for the over-seas shipping, in which transhipping and warehouse facilities are an important factor.

To the north of the property two piers, each 1400 ft. in length, are planned. The initial improvement will provide for the construction of the westerly pier, with a quay wharf extending south along the West waterway to West Lander street. Sheds with all modern conveniences for rapid and economical handling of cargo from ships of large tonnage will be built on the pier and quay. Back of the pier and quay a cold-storage warehouse is planned, also concrete warehouses for general storage purposes.

It is proposed to make of this improvement a transhipping, warehousing, and industrial terminal, in some respects modeled after the Bush terminals at South Brooklyn, New York. The tentative plan contemplates an ultimate expansion that will require more ground area, consequently this is designed as the initial unit of a much larger improvement. The property is exceptionally situated in regard to railway connections, and is also conveniently placed in relation to the Duwamish waterway. It can be easily served from near-by freight yards, and so lies, in relation to them, that the movement of the cars well be head-on to the ships. The situation, as a whole, makes possible an



PLAN OF HARBOR ISLAND PROJECT.

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economical and convenient switching scheme, which it is proposed to take full advantage of.

The initial improvement provides for facilities as follows:

Dock frontage, lineal feet	4,100
Sheds, square feet	226,250
Concrete warehouses, square feet	320,000
Cold storage warehouse, square feet	120,000
Estimated cost of this improvement, including land, allowing a safe margin for contingencies	$2,500,000

The sixth improvement contemplated by the Port Commission is not given in the list of tabulated improvements. It includes the construction of a ferry boat for Lake Washington and the necessary ferry slips, together with wharves suitable for local lake vessels.

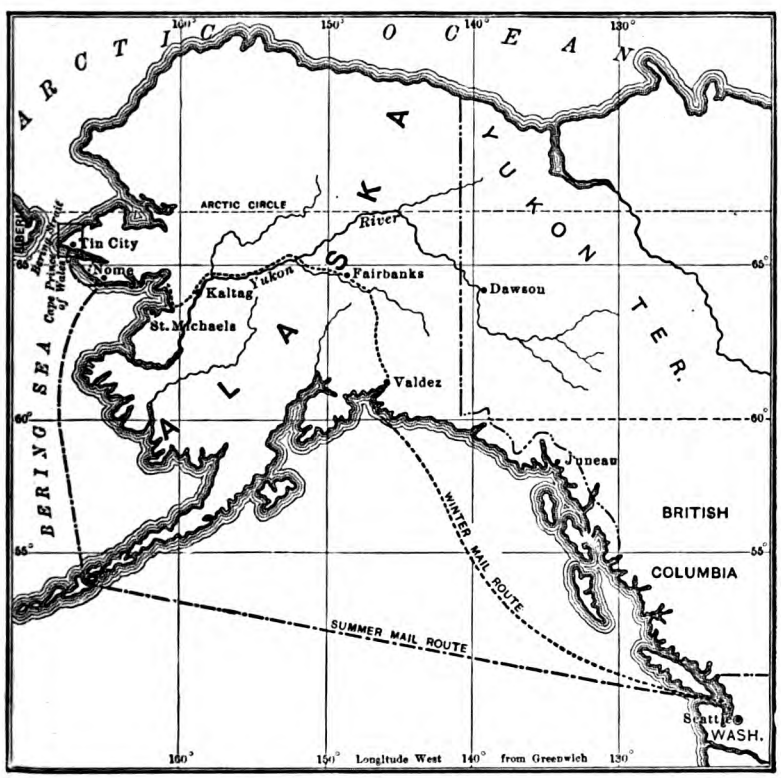
The initial improvement will provide, in addition to the accommodations for the ferry, the following landing frontage:

	Lineal feet.
Leschi, wharf frontage	500
Medina, wharf frontage	450
Bellevue, wharf frontage	450
Total	1,400
Estimated cost of improvement, including land, ferry boat, and landings, allowing a safe margin for contingencies	$150,000

The dock frontage to be added to the port for these improvements will be as given in the following table:

Classification.	Lineal feet of frontage.
Deep-sea shipping	9,456
Coastwise and local	3,065
Motor boats, etc	4,565
Total	17,086

The total is a little over 50% of the present available dockage, which is approximately 34,000 lineal feet. The effect will be greater than the figures indicate, for the reason that the new improvements are better equipped.



SEATTLE'S POSITION WITH RELATION TO ALASKA.

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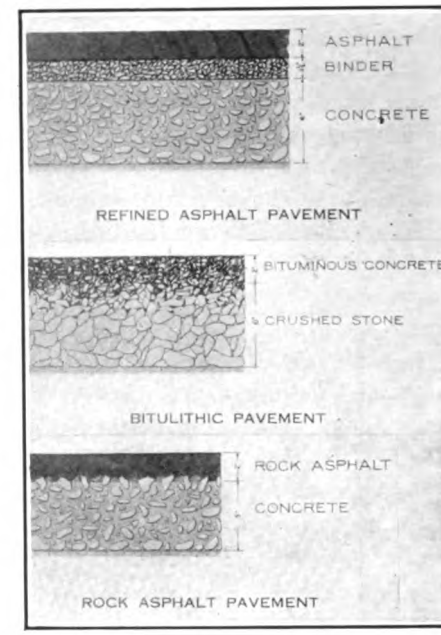
Paving in Salt Lake City*

By D. H. BLOSSOM †

THE first paving was laid in Salt Lake City in 1891, and consisted of 2296 square yards. From that time up to the present, approximately 30 miles of asphalt pavement has been laid, 3¼ miles of macadam, ⅓ mile of cement, and ½ mile of bitulithic. The ordinary sheet asphalt will be first discussed, as that is the pavement most commonly used and with which the general public is most familiar, and what the general public usually thinks of as 'pavement' when such a term is mentioned. Most asphalt pavements in Salt Lake City are laid on a 6-in. concrete base with 1½ in. of binder and 2 in. of topping. The concrete base is what is known as a 1-3½-7 mix, and is laid directly upon the subgrade.

The binder-course consists of hard, durable stone varying in size from 1 in. downward. The stone is heated to from 200 to 325° F. Stone and sand are measured separately, and in such proportions that the resulting aggregate will contain by weight, material passing a No. 10 mesh screen between 25 and 35%, and the bitumen added to this mixture shall amount to from 6 to 9% of the entire mixture. Such a course, when laid, shall form a comparatively dense and compact mass capable of sustaining the asphalt wearing surface without vibration.

There are two principal reasons for using the binding course. One is to furnish a foundation for the topping to which it will adhere and prevent creeping, and the other is to prevent, to a certain extent, moisture working up from beneath the pavement and coming in contact with the under side of the



topping. The top or wearing surface consists of the following material:

Asphaltic cement, 10 to 13.5%; portland cement or stone dust passing 200-mesh sieve, 10 to 15%; sand passing No. 80 sieve, 18 to 36%; sand passing No. 40 sieve, 20 to 50%; sand passing No. 10 sieve, 8 to 20%; sand passing No. 4 sieve, 4 up to 10 per cent.

The mud and asphaltic cement shall be heated separately to about 300°F.,

*Read before the Utah Society of Engineers, Oct. 18, 1912.
†City Engineer, Salt Lake City.

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the sand in no case exceeding 375° and the asphalt in no case exceeding 325° F. The sand is then placed in a suitable mixing apparatus and the requisite amount of bitumen or asphaltic cement added, after which it is combined into a thoroughly homogeneous mixture. The asphaltic wearing surface is hauled to the work in wagons provided with canvas or other suitable cover, and is delivered on the work at from 230 to 280°F. It is then spread with rakes to a depth such that when rolled, the ultimate thickness shall not be less than 2 in. The initial compression is effected with a three-ton roller and the final compression with a ten-ton roller.

Nearly all of the asphalt used in rerent years has been furnished by the Barber Asphalt Co. of California and is a substance produced in the process of oil refining. The material is shipped in barrels and is refined and tested to the proper degree of penetration before being shipped. No flux or any other material has to be added to make the asphalt of proper consistence. All that is necessary is to use proper precaution in the melting and heating process to prevent burning.

On all modern plants, the vat in which the bitumen is heated is provided with some mechanical means of agitation to prevent uneven temperature in any portion of the vat. In my opinion, more damage has been caused by overheating the material during the process of mixing than by any defect in the material itself. In the plant that has been used for the preparation of most of the material that has been used for work in Salt Lake City, the gravel and sand become overheated, and when bitumen is added, that portion that comes in contact with each small particle of sand or gravel is scorched or burned, with the result that the life of the asphalt is destroyed much after the same manner that a piece of rubber is destroyed by overheating.

Another very destructive element is water, and the present method of street flushing is having its detrimental effect. This is especially noticeable wherever cracks appear in the surface or along the street car tracks where the vibration along the rails causes the cracking of the pavement and the raveling and buckling of the edges. In a climate similar to Salt Lake, where there is a comparatively wide range of temperature during the season, great care should be taken in the proper tempering of the material in order to get the proper penetration. If mixed too hard it will crack in winter, and if too soft, it will roll and creep in summer. Especially is this so on streets where there is any perceptible grade. The best authorities agree that the maximum grade upon which it is safe to lay ordinary asphalt paving does not exceed 5%, both from the standpoint of creeping and slipperiness. This is about the grade of that portion of State street between First South and South Temple streets. Until the present season, it has for the most part been customary to run the paving material up to and flush with the outer rail of the street car track, while a brick or stone toothing has been used on the inside.

On all paved streets the street car company is required by franchise to pave the entire area between tracks and 2 ft. outside of the outer rail at their own expense and with the same character of material as that used by the city. At present they are for the most part using wooden ties, these ties being laid upon a concrete sub-base with a sand cushion between the tie and the concrete. According to the plans, about 1½ in. sand cushion should be used,

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whereas in most cases the Utah Light & Railway Co. uses from 2 to 3 in., which from a paving maintenance standpoint is too much, as it allows more or less vibration and consequent raveling of the pavement adjacent to the rail.

In order to avoid this difficulty as much as possible, the plan has been adopted this season of laying a double row of paving brick outside of the rail as well as toothing inside of the rail, thereby preventing to a large degree the vibration which is a direct detriment to the paving laid directly against the rail. Authorities seem to differ as to width of the toothing that should be employed, the object being to have just enough to get away from the immediate vibration of the rail.

Bitulithic Pavement.—Bitulithic pavment, as nearly as I can determine, was first laid by Warren Brothers Company in 1901. Up to January 1, 1912, there had been laid in one hundred cities of the United States something over 20,000,000 yards of bitulithic paving, and there was an increase in 1912 of 48% in yardage laid over that in 1911, which would indicate that the pavement was fast growing in popularity. Up to October 1, I am informed that 6,337,000 yards had been contracted for the present season. Scientifically considered, bitulithic pavement properly constructed should be more durable than the ordinary so-called asphalt pavement. In Salt Lake City there is only one example of this kind of pavement, consisting of approximately 9000 square yards on North Main street between North Temple and Second North streets and Center street from First North street to Second North street. The pavement as here constructed is built as follows, the same having been constructed the present season:

The curbs and gutters are prepared in the same manner as in the case of asphalt pavements. The subgrade for the street paving is excavated to the proper depth and thoroughly rolled with a twelve-ton road roller, after which the sub-base material is spread and leveled to the proper depth. The sub-base material in this case consisted of crushed limestone varying in size from 3½ down to 1½ inches. Considerable difficulty was experienced in obtaining suitable material for the base of this pavement, crushed boulders at first being tried without success, the difficulty being that the small boulders or coarse gravel would pass through the crusher without being crushed, with the result that instead of having an angular product from the crusher, about 90% of the surfaces were round and smooth. This made the rolling and compacting of the base material a practical impossibility, inasmuch as there was no interlocking effect between the different particles of the aggregate, the result being that the mass would constantly creep ahead of the roller. Only a small amount of this material was delivered until the defect was discovered when the material was changed to crushed lime rock, which was entirely angular as regards its physical appearance.

The one difficulty experienced with this material was that of getting it properly graded and having the finer material and dust screened out. There are several grades of limestone in this immediate vicinity, some being much softer than others, and in this case the hardest material obtainable was sought. Some criticism was offered to the use of limestone at all, inasmuch as the city's experience with this class of material in macadam pavement on Second avenue, Sixth East, and Tenth East

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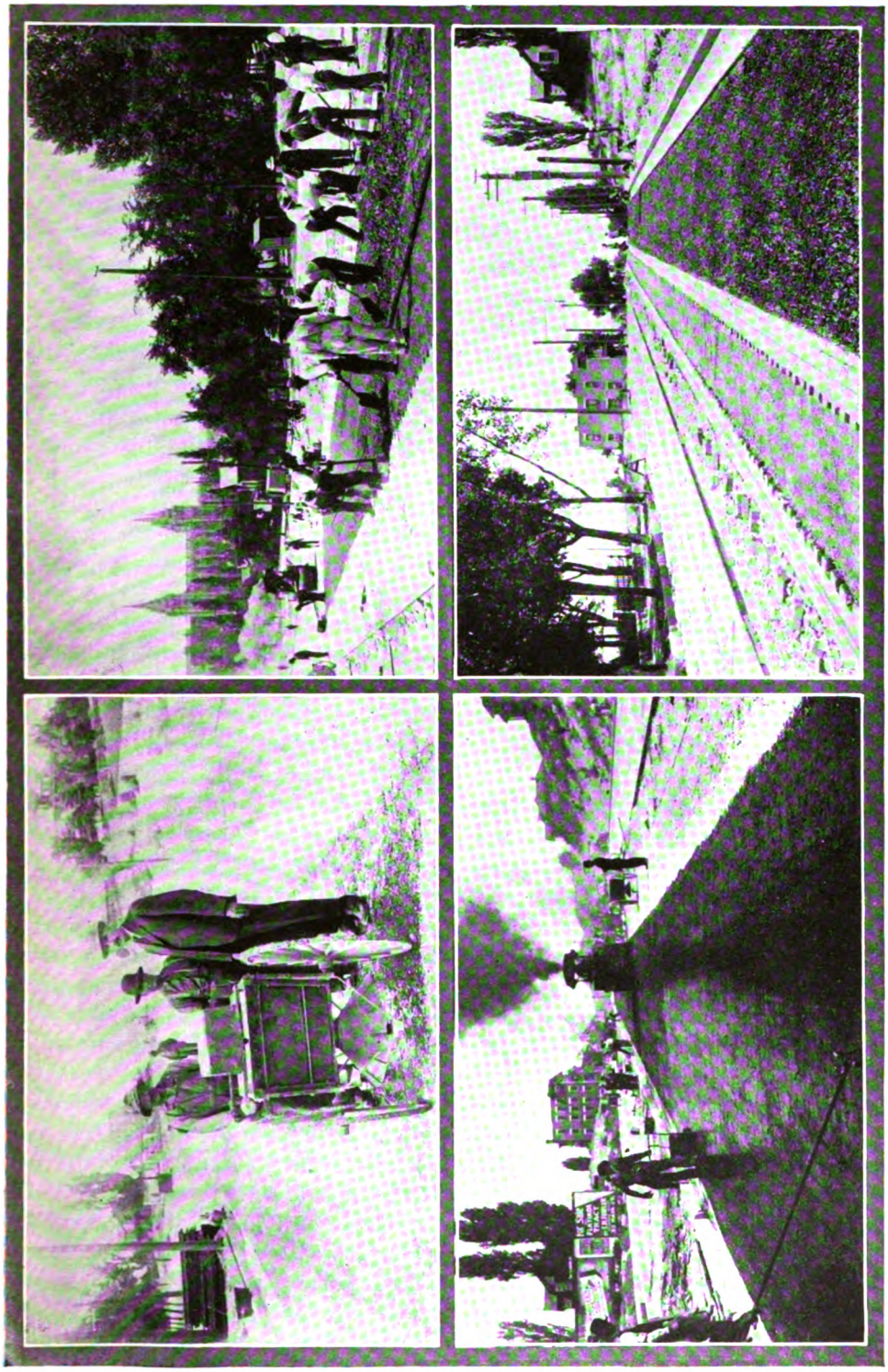

NORTH MAIN STREET. BITULITHIC WEARING SURFACE.
CENTER STREET. CRUSHED ROCK FOUNDATION.

NORTH MAIN AND CENTER STREETS. BITULITHIC SAND-PAPER FINISH.
NORTH MAIN STREET. BITULITHIC SQUEEGEE COATING.

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streets had been very unsatisfactory, but this is hardly a fair comparison, as in the case of the bitulithic pavement the base is in no way directly effected by the traffic nor is it exposed to the atmosphere.

After the material, graded as above stated, had been properly leveled, the whole mass was again rolled with a twelve-ton road-roller until it was thoroughly compacted, or until there was no tendency to creep ahead of the roller, the depth of the sub-foundation after rolling being 4 in. After the rolling had been completed, the entire surface was sprinkled with a coating of refined asphalt or bituminous cement, the idea being to more firmly cement and bind the base into one compact mass. The base thus prepared is more or less porous and filled with voids, the object being to allow a portion of the topping to penetrate the base, thus making one compact mass of both the base and the topping and thereby preventing any possibility of creeping or rolling.

After the sub-foundation has been prepared as just stated, the wearing surface is prepared as follows: crushed boulders, boulder chips, and clean sharp sand, and no lime rock or other soft material being used in its preparation, the preparation being entirely mechanical and accurate as regards proportions and mixing of ingredients. The stone is heated in a mechanical rotary heater to a temperature of about 250°F. and elevated to a screen having sections with various sized openings where the material is sized or graded into seven different sizes or grades varying from 1½ in. down to a fine dust. Samples of this material are taken every half hour by a chemist who makes a sieve test and determines the exact proportions of each size necessary to produce a mix with the least possible voids; these proportions are furnished to the man in charge of mixer, and the different sizes of material are weighed on a special scale containing seven beams, one for each class of material. It will therefore be seen that, scientifically considered at least, the mixture is as near perfect as one can make it and the underlying principle of the bitulithic pavement is its inherent stability and its lack of voids.

After the aggregate material for the topping has been properly weighed, the change is dumped into a 'twin pug' mixer, where the proper amount of asphaltic cement by weight is added to thoroughly coat each particle of sand and crushed stone. The bituminous cement is also heated to about 250°F. before being added to the aggregate. The machine in use on this particular job would turn out five batches of 1100 lb. each every 10 minutes, or sufficient to cover 21 sq. yd. of surface. The topping thus prepared is carried to the street in wagons properly covered the same as the asphalt topping material, and it is spread upon the properly prepared base in a similar manner with a sufficient thickness to finish, when properly rolled, to a depth of 2 inches.

After the final rolling, and before the surface has entirely cooled, a 'flush coat' of pure asphaltic cement is spread over the surface by a specially constructed spreading device known as a 'squeegee,' upon which, and while the flush coat is still hot, a layer of stone chips is sprinkled, these chips first having been heated to approximately 250° F. The whole mass is again rolled with the heavy roller until the chips are thoroughly embedded in the topping, giving it a roughish or sand paper finish, which makes this class of paving especially well adapted for medium heavy grades up to, say, 10 and 12%. The one chief

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objection to the use of bitulithic pavement seems to be the fact that it is known as a 'patented' pavement, and people object to paying a royalty.

It is not a monopoly pavement, as some suppose, inasmuch as Warren Brothers enter into an agreement to furnish topping material at so much per square yard on the work, and they will furnish it to all contractors alike. The agreement filed with the city in 1911 called for a price of $1.45 per square yard, but this price varies according to locality, cost of freight and raw material of aggregate.

I do not believe that in streets where the sub-foundation is soft or inclined to be marshy, this class of pavement could be used with good results without a concrete sub-foundation, which would add materially to the cost, and in that case asphalt pavement would be cheaper, though perhaps less serviceable in the long run. The bitulithic pavement is especially adapted to streets where grades are prohibitive for asphalt pavement and which do not warrant the expense of stone block pavement.

Natural Rock Asphalt.—Natural rock asphalt was first laid in Salt Lake City in 1901 when Commercial street was paved. This pavement consisted of 2296 sq. yd. with a frontage of 674 lineal feet. Other streets paved with the natural rock asphalt are West Temple street and South Temple to Fourth South streets, State street from South Temple to Fourth South streets, Second South street from West Temple to First West streets, and walks and drives around the City and County building. There has been so much controversy during the past season regarding the merits of Utah rock asphalt, that it is with some hesitancy that I attempt to discuss the subject, inasmuch as the records in the city engineer's office, in so far as I have been able to determine, indicate that with the exception of Second South street between West Temple and First West streets, a small amount used on the street known as Postoffice place, and that around the City and County building, the rock asphalt used was a California product and not a Utah one.

If all of the Utah product would stand up as well under heavy traffic conditions as that around the City and County building has stood up under light traffic, the Utah product should make the ideal pavement. This pavement was laid in 1894, and, as we have been informed, it is laid directly upon the natural surface with no sub-base material of any character whatever. The material used was quarried near Thistle, Utah, and was delivered at the work directly from the cars. It was then heated in a crude vat with steam appliances and spread upon the natural earth, which had been previously rolled with a hand roller. The coarser nodules were raked out and thrown aside, while the balance was again rolled with a light hand roller, this having been the only treatment applied to it.

The pavement has been down for 8 years with no repairs whatever so far as I have been able to determine. The small holes or pitting effect that is now noticeable is due to the fact that the material as it comes from the mine is not uniformly saturated with bitumen, some being extremely lean and some exceedingly rich. It is the lean portion of the material that causes the pitting, as these hardened lumps gradually become detached from the rest of the mass, leaving the holes and depressions now seen in the pavement. As nearly as I can determine, the mixture as used around the City and County

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building contained about 12% of bitumen, about 65% of petrolene, and 35% of asphaltene, the petrolene giving it its elasticity and the asphaltene its hardness. These were fortunately about the ideal proportions to give the best results, hence the long life of the pavement.

I have also recently taken up some sidewalk laid with the Utah product some fifteen years ago, the material having the appearance of being as 'lively' as when it was laid; one sample giving 14% bitumen, another sample giving 8.6% bitumen. The one great advantage, as it appears to me, that the natural product has over the artificial product is the fact that weather conditions and exposure to the atmosphere does not affect the natural product, while it does affect the artificial product. In other words, there is a certain oxidizing effect that takes place with the artificial product both from exposure to air and water that changes its chemical make-up, changing the petrolene to asphaltene and causing the pavement to become brittle and hard, thereby producing cracks and rapid disintegration. On the other hand, the natural product is not affected to any great extent by nature's influence.

The great difficulty that appears to me in the extensive use of the natural product is the fact that it appears next to impossible to obtain a uniform product in its natural state. There is either an excess of bitumen or a scarcity of it, and even in the same shipment of material there are lumps or nodules of the base material carrying very little bitumen. I believe that by proper grading and mixing the crude material, an ideal mixture can be obtained, but it is questionable whether such a process would not entail such an expense as to make the price of the mixture prohibitive as compared with the refined product.

NORTH MAIN STREET. BITULITHIC.

SEVENTH EAST STREET. ASPHALT AND CENTRE PARKING.

In drawing the present specifications, an effort has been made to provide for a uniform product either by mixing different proportions of the crude material to obtain a correct mix, or by adding an artificial flux to the lean material or sand to the rich material, as the case may be. The specifications to be used on Fifth East street also call for a 5-in. concrete base as compared with a 6-in. base ordinarily used, and no binder, as has been the case with the ordinary asphalt pavement. To offset the omission of the binder, the specification calls for a roughened surface made by sprinkling the surface of the concrete with crushed stone before the initial set takes place, leaving them only partly embedded. This will fur-

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nish a better bond for the asphalt wearing surface and prevent creeping or rolling during hot weather.

The prices bid for this class of material for the Fifth East paving are the lowest of any ever received for paving of like character in Salt Lake City, viz.: $1.74 per square yard, and while I am unable to understand how a contractor can make this low figure on a material that is 90% sand and pay freight charges for sand at the rate of $1.70 per ton, which can be had delivered on the work from the pits adjacent to the city at 55c. per yard, I am of the opinion that if the present specifications are followed, a first-class paving will be had for less money per square yard than any paving of like character heretofore laid in this city.

Electrifying the Oilfields

By A. EMORY WISHON*

Four years ago the sun rose in the central California oilfields and shone down on scattered derricks, new unpainted camps, and long, deep, dusty roads. An endless line of perspiring teams, laden with pipe pulled away from the crowded freight yards to scatter more derricks and camps on the great barren plains that once sold as poor sheep pasture for a dollar an acre, or could be rented for a few cents per year.

The rush was on. These same plains were now selling at from $500 to $5000 an acre. New wells were coming in daily, while now and then a gusher contributed added excitement to the foreign capitalist, and made the discomforts of the desert less apparent to the man on the job. Wages were high, rents high, meals high, the price of oil high, and everyone was happy, except a few 'hold-overs' whose pay-day balance had disappeared, and for whom on this beautiful sunny morn the cup that cheers had no attraction and the future no hopeful aspect. All night long the faro bank had been doing business; the elusive roulette wheel had purred out its soothing sympathy and encouragement, and the bones on the crap table had rattled on, while down below, the studd and draw games kept the money in circulation. The same sun was exposing the cheap glitter and spangle of the dance halls, under its glare the painted beauties were fading into grim reality. The bartender mopped off the bar and his brow with the same towel, and sat down. The day man was coming on.

Out in the fields hundreds of engines puffed and blew and gurgled and knocked, trying to run on hot water instead of steam. Everyone knew that the long uninsulated pipe-lines were the cause. Many more crude boiler installations dotted the field, hissed, leaked, and back-fired. Probably one out of every twenty was being re-tubed and several others shut down with the scaling crew on—but "what was the difference, oil for fuel cost nothing, and you needed the extra men anyway."

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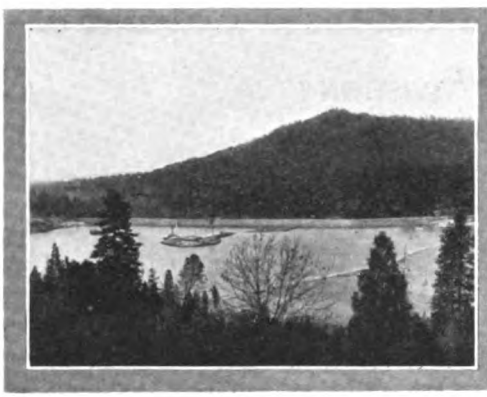
The one idea was to prove the territory, and after it had been proved, to drill with all possible speed. Oil was what was wanted, and the question of operating efficiency was given but brief consideration, and then by but a very few. In this mad rush, with the same germ of gamble, hope, and excitement working in every inhabitant of the field, what else could have been expected. It took a bilious individual from the outside, well trained in operating efficiency, to get into the field and out again without losing his head entirely, and to stop long enough to reckon on the possible saving that could be made by economical operation. Just as soon as this was reduced to actual figures by this bilious individual, he, too, was in the same class as the rest of the field, except that he was mentally deranged on a different phase of the subject.

At first, piping pure water into both the Coalinga and Midway fields was considered, as the bad local water was largely responsible for most of the boiler troubles. The question of a supply of water for the respective fields was gone into, the finding of a sufficient quantity of the proper quality within a reasonable distance of the field being the prime factor of importance. The Coalinga scheme called for piping 40,000 gal. of water daily, a distance of 38 miles and with a lift of over 800 ft. It seemed the only relief for the field and the promotion of the scheme was well under way and a large part of the supply had been contracted for, when the question of electrically operating the wells was brought up for serious consideration. On going closely into the subject, it was found that already motors were being used in the operation of oil wells in the Pennsylvania field. Even at the first glance the comparative merits of the two schemes was apparent, and the scheme of piping water into the fields was buried without so much as a wake. All those immediately concerned turned their undivided attention to the question of electrically operating the wells.



CRANE VALLEY DAM AND PORTION OF RESERVOIR, SAN JOAQUIN LIGHT & POWER CORPORATION.

INTERIOR OF SAN JOAQUIN HYDRO-ELECTRIC POWER-PLANT, SHOWING FOUR 4000-KVA. UNITS.

While motors were in use in the Eastern fields to a small extent (and consequently at first glance the situation looked simple), it proved to be far more serious. The depths, the formation, the oil, the rigs, and a hundred other things were found to differ ma-

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terially in the Pennsylvania and California fields, and while it had at first seemed a simple problem, it took the best brains of the electrical profession and of the oil industry, and the expenditure of thousands of dollars, to bring the oil-well motor to its present state of perfection.

Even on the Pacific coast in the early days of the Kern field, electrical operation had been tried but had failed. Most of these early failures were due largely to the fact that those who represented the electrical profession tried to tell the oil man how to drill or pump a well with an electric motor, instead of trying to build a motor that would drill or pump a well according to the ideas of the oil man. Profiting by this mistake, the first move made by the electrical manufacturing companies was to coöperate with the oil companies by sending their electrical engineers and designers into the field to learn oil-well conditions.

Some experimenting was of course carried on in the laboratories and at the factories, but the greater part of the work was carried out by operating with various apparatus, under all conditions at the wells in the field. The word was passed out to "design and build to meet any operating condition of the field, and to arrange the motor control so as to make it practically identical with the old steam engine control." In other words, this time an electrical equipment was to be built to conform to the ideas of practical oil men, and not to attempt to change the oil man's ideas to conform to the electrical equipment.

The motor as it stands today, more compact and more flexible in its handling than the old steam engine, meets every operating condition, and more. It is capable of running forward or reversed and with a range of speeds as great as the engine. The saving to the oil companies, by adopting electric power, is from 50 to 300% over former operating costs. While the credit for the actual electrical design of the motor must be given to the electrical profession, the credit for the operating success of the motor must be shared with the practical oil men, who worked hand in hand with the electrical experts in developing the apparatus, and who pointed out the exceptional conditions it must encounter.

Not only did the electrical features of the motor offer a serious problem, but there were financial problems as well. It meant financing for the expenditure of several million dollars for the enlargement of reservoirs and power-houses and in the building of transmission and distribution lines, to distribute electricity to operate a new practically untried machine and with not a single horse-power contracted for.

The experiments had, however, absolutely convinced those in close touch with their progress that the motor was a mechanical and electrical success. On studying carefully the operating costs of each specific property of the field, each additional report submitted by the different engineers went to prove that in this day of specialties, the question of producing power for the operation of the oil well was a distinct and separate business from the development and production of the oil, and that the large hydro-electric central station could operate at a profit and still sell current to the oil company at a price that would allow a large margin of saving over previous operating costs where they had used their own oil or gas for fuel. The skilled help that the large electric stations could afford to employ, the class and size of machinery installed, and the

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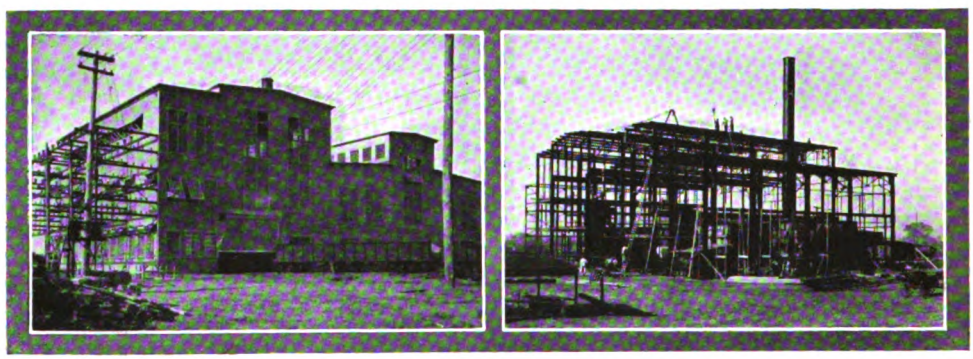
big saving made in operating labor, represent the great advantages of scientific, centralized power over scattered, individual efforts.

The electric power now used in the Coalinga, McKittrick, Midway, Sunset, Lost Hills, and Kern River oilfields is furnished by the San Joaquin Light & Power Corporation. This company represents the same interest that first looked into the question of piping water into the fields. Having worked with the oil-well motor in its development and familiarizing itself with all the conditions and requirements of the oilfield, the all important question of continuous service of power for this work was recognized as the vital point from the very start, and the system was built, regardless of expense, to meet this condition.

Not only has the distribution system in the immediate oilfield been built with the thought of continuous service, but the entire property of the San Joaquin Light & Power Corporation (during the rebuilding that has been going on for several years) has been laid out and constructed so as to guarantee a service that is as nearly continuous as machinery, brains, and money can make it.

Fifty-four miles northeast of Fresno, at an elevation of 3500 ft., is the great Crane Valley dam, that was finished about eighteen months ago, at a cost of approximately a million and a half dollars. This dam is 1860 ft. across the crest and 150 ft. high, forming an artificial mountain lake that is sixteen miles around the water edge and impounding 51,000 acre-feet of water, a quantity sufficient, without any inflow, to operate the chain of power-houses below, through any exceptionally dry year. However, there is always an inflow into this lake, the watershed reaching far back into the high mountains. This is the first step in the line-up of continuous service developments, the water that drives the generating machinery being assured throughout the year, regardless of how short any one particular season may be.



STEAM-POWER PLANT AT BAKERSFIELD, COMPLETED AND UNDER CONSTRUCTION.

From this dam the water is carried through a concrete lined ditch 4.2 miles in length and through four tunnels and thirteen steel flumes to the intake reservoir of plant No. 3. This reservoir holds sufficient water to operate No. 3 plant for three hours, and was built in order to furnish water in the event of a break in the No. 3 ditch. The water flows from this reservoir through a pressure pipe-line to No. 3 plant, under 400-ft. head generating 2000 kva. at this station. From here the water is carried

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down the Northfork channel, where it is picked up farther on by the ditch known as No. 1, which is 4.62 miles long and which passes through twenty tunnels and three steel flumes. The ditch has a concrete corewall on the lower side, which absolutely protects the lower bank, and the tunnels are all concrete lined. At the lower end of the ditch is the pressure reservoir for the main San Joaquin power-house. This reservoir, built for the same purpose as No. 3, is capable of furnishing water to the power-house below, which is known as the 'San Joaquin plant,' under full load for a period sufficient to allow ample time for any ditch repair. Three separate pipe-lines are brought down the hill from this reservoir, any two of which are sufficient to carry 50% overload on the plant. The difference in elevation between No. 1 pressure reservoir and the water-wheels is 1405 feet.

The San Joaquin plant is the last plant built by this company, having only been completed 15 months. It is equipped with modern machinery and appliances throughout, and has a rated capacity of 16,000 kva., with a guaranteed continuous overload capacity of 25%. From this plant two separate lines are carried out over the San Joaquin valley, 17 miles below, to the Copper Mine substation. Here starts the great 60,000-volt loop that circles the southern part of the San Joaquin valley, running west to the eastern border of the Coast range, down through the Coalinga, Devil's Den, Belridge, McKittrick, Midway, and Sunset fields; then east and north into Bakersfield and out through the Kern field, and north to the point of beginning, a distance, when complete, of 370 miles. This loop is built of 50-ft. poles, 350 ft. apart, with 7-ft. triangle, pin-type insulators, carrying 3/0 seven-strand aluminum cable. From the Copper Mine substation the 30,000-volt system, which is the original system, runs both north and south, the current being stepped down from 60,000 to 30,000 volts at this point. However, as the 30,000-volt system does not feed the oilfields, it will not be included in this description.

The big 60,000-volt loop is fed on the north by the San Joaquin and No. 3 power-houses, having a total of 18,000 kva. In Fresno there is a 1000-hp. steam relay, while in the south, at Bakersfield, there is on this loop 7500 kva. in steam turbines. At Bakersfield the Canyon plant (hydro-electric) of 2000 kva. is also tied to the 60,000-volt loop, and at the present time on Tule river there is under construction a 6000-kva. plant that will tie to the loop at Strathmore; also about the middle of the loop, on the west side, the Henrietta substation will soon feed back into the line from the Santa Maria oilfields, where there will be a 2000-kva. steam turbine.

On this loop are switching stations and substations at intervals, so that the loop is sectionalized, allowing any section in trouble to be cut out while the remaining part of the system will operate. Operators are on duty at each of these substations night and day, and all stations are connected by private telephone, so as to make operating conditions absolutely flexible.

The Coalinga field for the past year has been fed by a single line, but at the present time, a second line is being built that will also give the Coalinga field double service. These substations on the loop are of two types, the outdoor type, where only the switching apparatus is housed and the transformers used are placed out in the open; and the other type, the one used in the oilfields, is enclosed, built of structural

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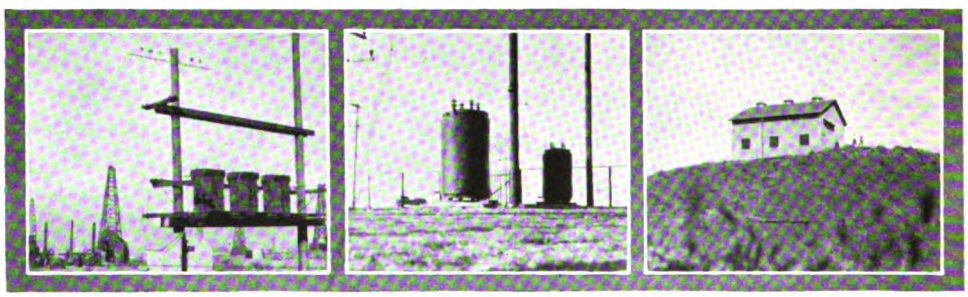
steel and hyrib concrete, making them absolutely fireproof. In all substations on the loop, extra transformers are carried in case of a transformer breakdown. The switching apparatus is arranged so that the section of the transmission line, on either side of the substation, can be cut out, or so that the substation itself can be cut entirely away from the transmission line.

The secondary lines, which are 4-wire, 10,000/6600-volt, are generally carried on 40-ft. poles, 8-ft. arms, 4-pin, flat construction. In the oilfields these secondary lines are in many cases built in loops. For instance, the Coalinga field secondaries are built in a loop running through the West field, out through the Northeast field, back down the Coalinga anticline, and into the station again. On these secondary loops, pole-top switches are installed about every three miles, enabling any part of the line that is in trouble to be cut out, so as to allow the rest of the field to be served during repair.

In the Midway and McKittrick fields, besides the different 10,000-volt loops that are built, the main secondary feeder leading south from the McKittrick substation, is connected with the main feeder running north from the Midway station. This, as for all other secondary lines in the oilfields, has pole-top switches installed every few miles and also where the laterals lead off from the main secondary feeders. It has been arranged throughout the fields, with different operators living near these switches, to open them on a call, and by this arrangement it is generally possible within a few minutes to find any trouble and cut the section of line that is in trouble entirely out of the system.

The lines of the power company are built to the property of the customer and 200 ft. into the property, at which point line fuses and an open-air type switch is installed, so that in the event of trouble on any property, the fuses where the line enters the property would blow, cutting the trouble free from the main lines and shutting down only the lease that might be having the trouble.



SANTA FE LEASE, MIDWAY. OPEN-AIR TRANSFORMER IN USE. M'KITTRICK SUBSTATION.

The distribution lines of the oil companies are generally carried on 30 or 40-ft. poles; the primary 10,000/6600-volt wire being carried to the central point of the property, where it is connected to a transformer bank. One transformer bank generally supplies from 6 to 10 motors. The motor voltage is 440 and the length of the 440-volt mains is generally limited to about 1000 ft. Even on the distribution of the 440-volt mains, wherever it is possible, the loop circuit is installed, completing from the 60,000-volt loop down

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to the distribution voltage the continuous plan of a ring system. Thus we have from the great storage reservoir in the mountains relay pressure reservoirs, duplicate pipe-lines, duplicate electrical machinery at the generating and distribution points, and a complete ring system on the transmission and distribution lines of every voltage, assuring readiness to serve and continuity.

The Rondout Siphon

By J. F. SPRINGER

THE Rondout pressure tunnel, or Rondout siphon, is one of the most notable features of the great Catskill aqueduct. Here is to be found, perhaps, the very greatest combination of constructional difficulties. At the Hudson river the aqueduct does indeed dip to a depth of 1100 ft. below the river surface and 1500 ft. below the hydraulic grade, but the tunnel itself is comparatively short (3000 ft.) and passes through rock of great solidity and uniformity. The necessary shafts, while involving excavation at low levels, proved only of moderate difficulty because of the generally reliable character of the strata. Where the aqueduct passes the valley of Rondout creek the tunnel is nearly 4½ miles long and penetrates strata of greatly diversified character and difficulty. One of the shafts, No. 4, a temporary working shaft, proved to be an exceedingly difficult piece of work. In connection with the Rondout siphon, a great deal of water was present and gave rise to many problems.

In sinking shaft No. 4, portland cement was found of great assistance, as by its use it was found possible to grout up in advance, strata through which the shaft had to penetrate. Shafts No. 1, 2, and 5 were sunk to rock by means of concrete caissons. The tunnel itself had to be lined with concrete and grouted up with cement grout or cement mortar back of the lining. The tunnel varied anywhere from 400 to 700 ft. below the irregular surface. The hydrostatic heads against which the cement operations had to be conducted varied up to 300 ft., or 130 lb. per square inch. It will thus be seen that portland cement played an important part in this great undertaking. The object in view in providing a rock tunnel with a concrete lining was twofold: to prevent leakage out, and to provide a smooth surface in order to facilitate the passage of water.

The excavation problems and allied questions for which solutions and answers had to be found, are of importance not only to those engaged in similar work, but especially to mining and other interests. Shaft No. 4 required 18 months for its construction. It was flooded six times. The concrete drop-shaft of shaft No. 5 broke in two, the lower portion falling away from the upper. At shaft No. 1 the cylindrical concrete shell stuck when part way down and could not be moved until subjected to a load of 250 tons. In the

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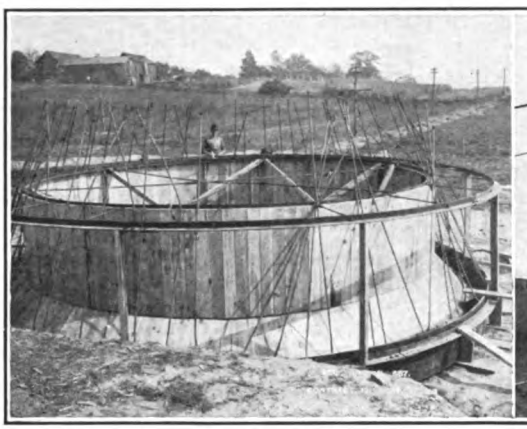
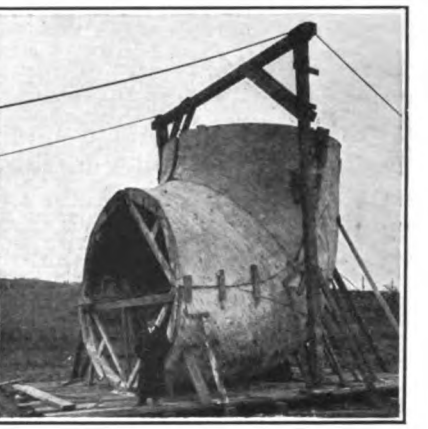
tunnel itself one or more points were passed where the rock was heavy and broken, and in fact of such character as to prohibit the use of poling boards, though unable to support itself in the wall of the excavation. In fact, water, difficult and varied rock, faults, concealed gorges, etc., combined to make the Rondout siphon a very hazardous enterprise from the standpoint of excavation.

The construction of the Catskill aqueduct has been, and still is, beset with difficulty; nevertheless, as yet there has been no serious collapse such as would necessitate any radical change of plan. In general, the engineers have gone ahead, knowing in advance with some degree of precision the conditions with which they would have to deal. This was made possible, in a very large degree, by the exploration work done with core-drills. The expense incurred in the carrying out of this work has been very large; but this expense is quite small when balanced against possible disasters which might easily have resulted from going ahead blindly or with less thorough information. There is reason to believe that the great dam at Ashokan reservoir has been correctly located; whereas a mistake might easily have been made. There is confidence that the Hudson river siphon has been placed at just the right point along the river; it might easily have been given a wrong position. The core-drills have supplied the essential information and have thus amply justified the expense incurred in their use.



STEEL SHOE FOR CONCRETE CAISSON SHAFT NO. 2



FORMS FOR DOWNTAKE SHAFT.

The rock formation at the Rondout siphon is quite diverse in character, varying between very soft shales and the hardest millstones. The strata are faulted and folded to a very great extent. Over the whole, hiding the configuration and position of the rock surface, lies a heavy covering of drift deposited during the glacial period. An attempt was made at a cross-sectional profile based on a study of the locality, the outcrops, and the like. The profile thus secured proved of value as a working hypothesis. As Mr. Lazarus White says: "It was qualitive rather than quantitive."

A great disaster might easily have resulted had it been depended upon as a reliable chart with the aid of which the tunnel might have been located. As the information supplied by the core-drills accumulated, the first profile required

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continued alteration. There is a deep gorge near the position of the present Rondout creek. This gorge is filled by glacial drift which forms the bed of the stream. Another hidden gorge is two miles distant, being near the downtake shaft of the siphon. The central depression near the creek, reaching as it did to the level of the sea, required that the tunnel be located 250 ft. below the sea. But the tunnel is not at the same level everywhere. The deepest portion is the south end, extending from a point a little north of the creek to about the foot of the uptake shaft. The northern portion of the tunnel is only 100 ft. below the sea; and the two levels are connected by an inclined section. The variation in level was due, in part, to the desire to avoid as much as possible construction in the Shawangunk grit, a rock of excessive hardness liable to contain fractures and open seams.

The sinking of shaft No. 4 has been described elsewhere in detail. It will suffice here to give a very brief account. The strata which had to be penetrated were as follows:

	Feet.
Glacial drift	6
Helderberg limestone	226
Binnewater sandstone	39
High Falls shale	92
Shawangunk grit	134
Total	497

A 4-in. bore-hole had been put through the prism which the shaft would occupy. Water was to be expected in the sandstone and shale. However, long in advance of reaching the Binnewater sandstone, that is to say, at the 80-ft. level, water came in through the bore-hole, catching the contractor unprepared and flooding the shaft to the 40-ft. level. The water was pumped out to a point within a short distance of the bottom, and preparations made to fill the bore-hole with cement grout. A nipple was driven in and casing attached. Within this a 1-in. pipe was put down to about the level of the grit, 363 ft. below the surface. The water was then permitted to return, thus providing for the elimination of the currents. The cement grout, made 1 to 1, was now put down the pipe, the purpose being to seal up the hole and its ramifications. As the grout was put in, the pipe was withdrawn. This hole seems to have given no further trouble. However, fears were entertained as to trouble below. These fears were abundantly realized, although no additional trouble of an especially serious character from water appears to have arisen until after the attainment of the 260-ft. level. At this moment only about 225 gal. of water per minute was coming in. However, while the sump was being drilled, there occurred a sudden inrush of 600 gal. per minute through one of the drill-holes. A second flooding now took place, apparently because of this flow through one small hole. The shaft was then unwatered, only to be flooded three times more in as many weeks. Water had now conquered five times. Large openings in the rock were ascertained to exist only a short distance below the point of excavation. One 8-in. crevice was only 1½ ft. below. If 2-in. bore-holes gave so much trouble, what would happen when larger openings were exposed? Effective preventive measures were imperative.

It was determined to attempt to seal the openings and connections with cement. Four grouting machines were set up at the surface, and 2½-in. piping with terminal 2-in. delivery tubing was put in place. When grouting was

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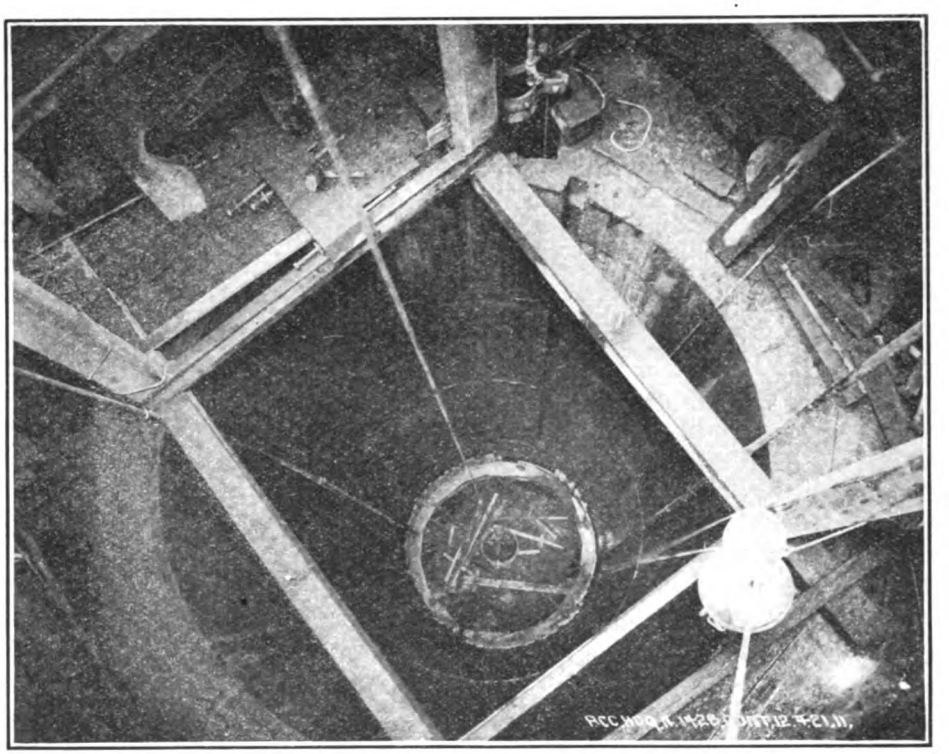
begun, trouble was experienced with back-leakage. This was overcome by mixing finely ground horse-manure with the grout. A total of 2900 bags of portland cement was used in these sealing operations. A few more holes were drilled and some additional cracks filled, 60 bags of cement being thus consumed. It was not deemed advisable to proceed with the excavation until further precautions were taken. There was still a distance of 100 ft. to the grit. Six drill-holes, three yielding 1-in. cores, and three 8-in. cores. were now put down through the intervening material, and another grouting process carried out. The pressure employed was 275 lb. per sq. in.; still only 175 bags of cement was consumed. This amount was comparatively so small that it was a question whether the problem had been an easy one, or whether it had been only imperfectly solved. Sinking was, however, resumed, and a depth of 320 ft. reached without serious mishap. A couple of collecting rings had been arranged, and the shaft was nearly filled with sinking pumps. It was now determined to construct a special pumping chamber off to one side, and to install in it a powerful plant. Before these plans were carried out, however, the sixth and last flooding took place. The special chamber was situated at the 309-ft. level and had a height of 10 ft. and a floor area of 17 by 24 ft. Underneath the floor a sump 5½ ft. deep and 16 by 22 ft. in horizontal section was provided. Its capacity was, accordingly, 14,500 gal. In this chamber were installed three horizontal condensing pumps, built by the A. S.



VIEW LOOKING DOWN SHAFT No. 5, CONCRETING IN PROGRESS.

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Cameron Steam Pump Works, New York City. Each of these was of the 24 by 10 by 20-in. size, and the combined capacity was 1050 gal. per minute. Steam was supplied by three 100-hp. boilers set up at the surface. It seems that this special chamber, with large pumping plant and sump, should have been provided at an earlier stage of the sinking operations. It would appear that if this measure had been taken at or near the 200-ft. level, provided that conditions permitted, only one flooding might have taken place. That this shaft earned the descriptive adjective 'wet,' will be readily granted from the foregoing and from the fact that 86,181,000,000 foot-gallons of water was pumped therefrom during the eighteen months of its construction. The total of cement consumed was 971 barrels.

At shaft No. 1, the overlying earth covering the rock was 83 ft. deep. It was proposed to pass through this bed, consisting of boulder clay, by means of an open cylindrical caisson of reinforced concrete. It is said that this shaft might have been sunk with the aid of timbers. The concrete caisson was employed, however, for the reason that the specifications required the removal of all timber down to the groundwater level before putting in the permanent lining. However, for a short depth timbering was employed. Then, at a point 23 ft. below the surface, a steel riveted cutting-edge was set up, together with an interior form, the latter to give shape to a section of the concrete caisson. The external cylindrical surface was formed by the clay wall of the excavation itself. In this way a caisson 25 ft. in height was constructed. There was then considerable weight resting on the cutting edge.

Excavation by pick and shovel was then started, a derrick taking away the spoil. This caisson sank vertically until a depth of 26 ft. was reached, when it began to deviate from the vertical. In part, the disposition to lean was corrected by increased digging beneath the high side. When it had reached the 34-ft. level, the skin friction of the concrete against the clay became so excessive that undercutting of the steel edge was insufficient to cause it to descend. It seems that the contractor was not permitted to use either air or water in sufficient quantity to soften the sides. The reason for this restriction was based on the fear that surface settlement might result, and that thus difficulty might arise in connection with founding the heavy siphon chamber which was to be constructed later on. However, permission was granted to inject a moderate amount of water through the grouting holes of the caisson. This procedure alone was insufficient, so it was determined to impose a load. Two hundred and fifty tons of earth was loaded on the caisson, using a suitable box as a retaining device. At length the 63-ft. level was reached. There was still 20 ft. between the cutting edge and the rock below. It was now determined to concrete this section instead of attempting to force the caisson itself down to the ledge. Accordingly, the shaft was excavated to full size through this intervening region and a central form set up, the clay wall acting as the outside form. When these preparations were completed, concrete was filled in, thus completing the lining of the lower portion of the earth shaft. The spaces between the caisson and the clay were filled with grout. It is thought that no appreciable settlement of the earth around the caisson took place.

The same general method of sinking was employed with shaft No. 2. A

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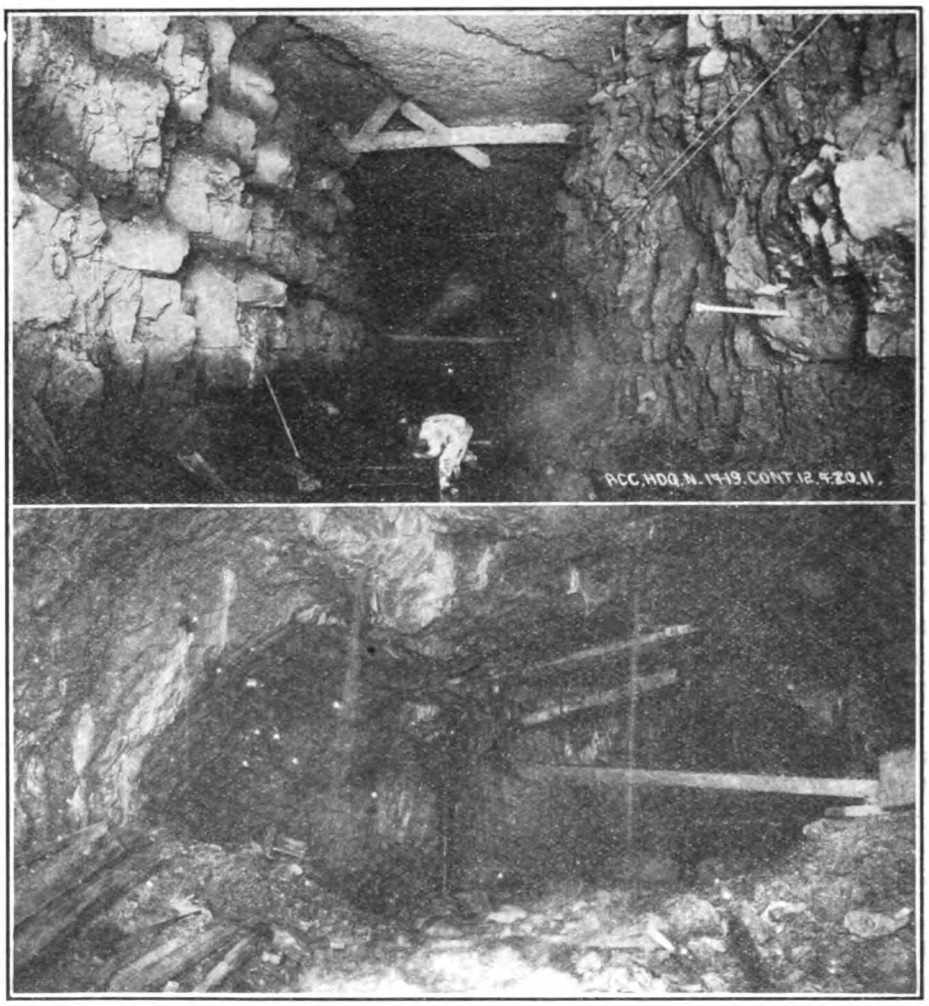
short distance below the surface the material to be penetrated was soft and fine, containing a good deal of water. It was essentially a kind of quicksand. When the caisson had descended to the 19-ft. level the vertical direction was maintained very well. The cutting edge was now undermined, when suddenly, without warning, the caisson dropped 7½ ft. in 35 seconds, the top disappearing below the surface. In fact, upon the caisson coming to rest it was found to have its top on a level with the upper surface of the soft oozy material. It is said that the caisson would have filled up had it dropped a few feet farther. Men working on the bottom felt themselves raised, and no doubt they were from the displacement of material. As the work went on, the caisson seemed to float around in the ooze like a huge cork, although weighing hundreds of tons. At the bottom of the lake of soft material were boul-



MUD SEAM IN ROOF, SHAFT 3, SOUTH
NORTH HEADING FROM SHAFT 4, SHOWING LARGE STREAM OF WATER ENTERING HEADING.

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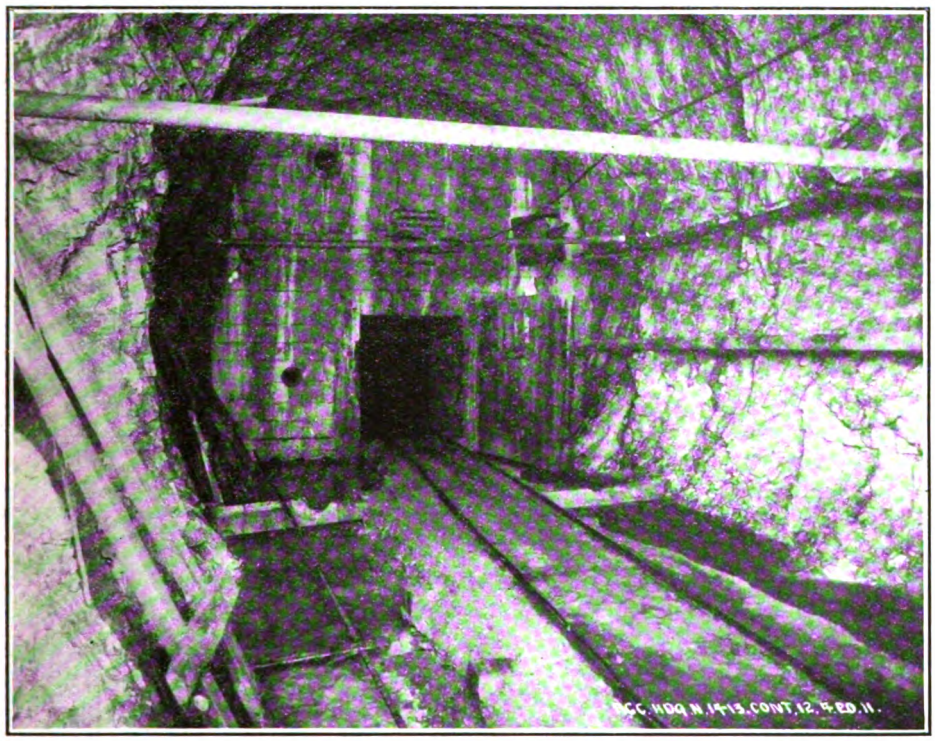
ders which had to be blasted. The caisson got out of the vertical position and was loaded with large amounts of earth in the attempt to bring it back in place. When the ledge was reached the caisson was 1.5 ft. out of vertical, and its centre of gravity was displaced 1.1 ft. However, as the great shell was several feet out of plumb in different directions during the sinking, the final position may be looked upon as an improvement. It has proved to be a very successful lining for the earthen portion of this temporary working shaft. Mr. White expresses the opinion that the caisson should have been provided with a deck about 10 ft. from the cutting edge, this deck having one or more openings for the reception of air locks, in case pneumatic methods had proved necessary.

At shaft No. 5 the caisson method was likewise employed. This caisson stuck very stubbornly once or twice. After undermining the cutting edge, bracing the earth, and permitting water to re-enter, dynamite was employed by the contractor. Several sticks were set off in the water. The caisson went down 3½ ft., but the following day the caisson parted, the cutting edge sinking 2½ ft. in soft clay. As the two portions were still in line with each other, the gap was concreted after it increased to 3½ ft. Reinforcement was placed in position before concreting, in order to bind the two portions together. Apparently, the accident was due in part to the upper portion of the caisson sticking, thus throwing a heavy tensile stress upon the walls. A break was the result due to the use of an insufficient number of rods.



CONCRETE BULKHEAD NORTH OF SHAFT No. 4.

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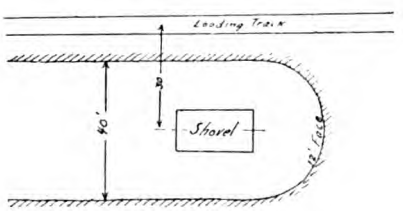
Mining on the Panama Canal

By C. R. FORBES

THE Panama canal is attracting especial attention just now on account of its nearing completion, and while all are familiar with the magnitude of the work, the difficulties encountered, the great sanitary victory, but little has been written describing actual details of value to the engineer. The following notes concerning the method of working in the big cut at Culebra were taken during a brief visit to the canal, and will perhaps be of especial interest to the mining engineers, since the work is similar to that of many of our large mining operations.

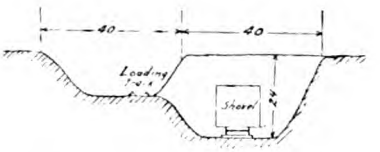
Method of Attack.—The method of attacking the cut is similar to other steam-shovel work and consists in first



PLAN OF PIONEER CUT.

taking a 'pioneer cut' through the centre of the canal. This cut is about 12 ft. deep and from 40 to 45 ft. wide; the shovel operates in the bottom of the cut and works against the 12-ft. face, loading into cars on the loading track as shown in the photograph and sketch. The shovel track is composed of 6-ft. sections which can be moved from behind the shovel, carried ahead, and bolted to the preceding section. The work of moving ahead is done usually while waiting for cars, but if this is not possible, little time is lost because it can be accomplished in a very few minutes.

Following the pioneer shovel, another one, at some distance, takes the second cut as shown; the second shovel works against a 24-ft. face and loads



CROSS-SECTION OF SECOND CUT.

into cars on a track placed in the original pioneer cut. In both the pioneer cut and the second, the loading tracks are 12 ft. above the shovel tracks; this distance is determined by the height to which the dipper can be raised, and must be such that it can easily clear the loaded cars when drawn up to its maximum height. After this cut has been taken, it may be widened to any width by other shovels working against the 24-ft. face on one side or the 12-ft. face on the other, and loading to a central track as shown in the sketch.

The work is continued in this manner until the desired width is obtained, when a new pioneer cut is started and the work of deepening the canal is repeated as before. The work may be carried on at many different places and with many variations in the above plan which may be made necessary to provide suitable grades for tracks.

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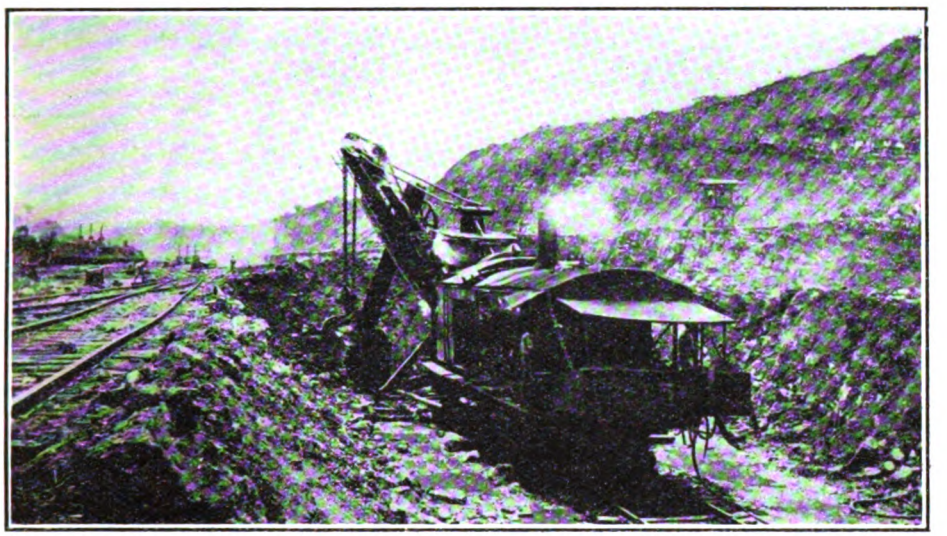
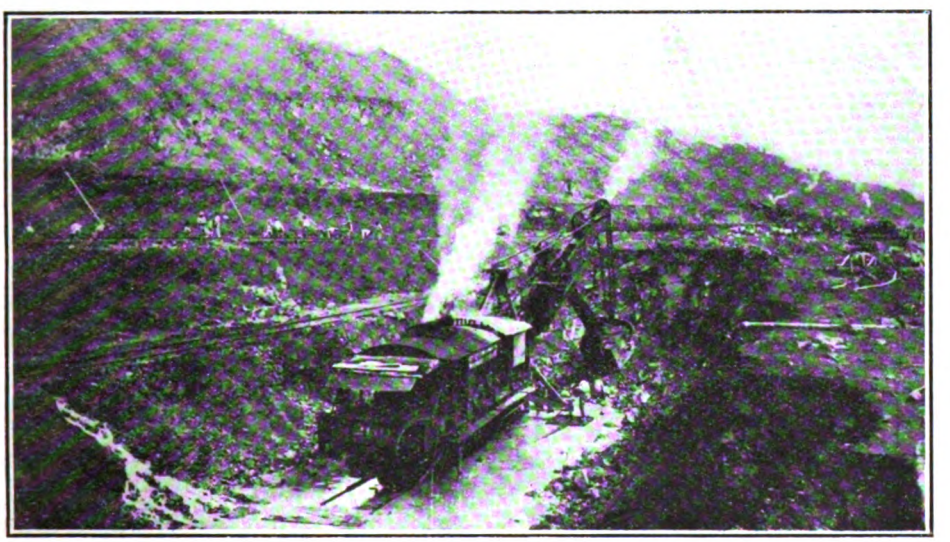
proper drainage, etc., but this is in general the plan followed.

Breaking Ground.—The ground is broken a considerable distance ahead of the shovels, as a rule, in order that there may be no danger of injury from the blasts, and also that there may be no chance of delay from the drilling and blasting operations. For breaking the pioneer cut, the holes are placed as shown on the page following.

The distance between holes will depend upon the kind of rock to be broken, and varies from six to ten feet. Most of the rocks are comparatively soft sediments, some of which could



MAKING PIONEER CUT.



MAKING SECOND CUT.

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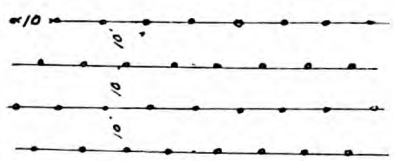
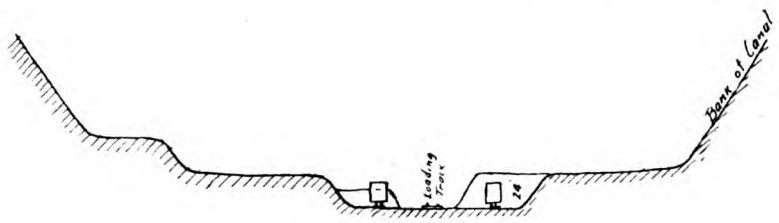
almost be excavated without blasting, but in places the sediments have been intruded by dikes of basalt or trap that are very hard to drill and require much powder to break.

The holes for breaking the pioneer cut are drilled 15 ft. in depth to the so-called 'powder grade,' which is three feet below the grade at which the shovel works; this is done to insure that the powder will be placed below the shovel grade and thereby diminish the danger of encountering any unexploded powder with the dipper. In breaking ground for the second and succeeding cuts, holes are drilled to a depth of 27 ft., thus making the bottom of the holes or powder grade 3 ft. below the shovel as before. The arrangement of these holes is practically the same as that used in the pioneer cut, the distance apart depending also upon the nature of the rock.

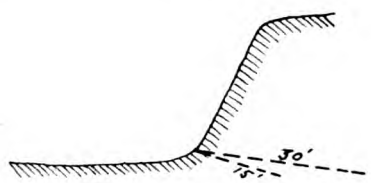


HOLES FOR BREAKING PIONEER CUT.

Another method of breaking the ground after the second cut has been taken, is by drilling flat toe holes into the bank as shown in the diagram; these holes are drilled alternately 15 and 30 ft. deep and from 3 to 5 ft. apart, and are bottomed 3 ft. below grade as before. These flat holes seem to give the best results and are used whenever possible. The accompanying photographs show a round of toe holes before and after shooting; in the upper one the wiring for the shots can be seen and the lower one shows the result of the blast. This particular round consisted of 22 holes 30 ft. deep, which were loaded with from 20 to 25 lb. each of 60% dynamite.



WIDENING AFTER SECOND CUT.



TOE-HOLES.

Charging and Firing.—The loading of the holes is in charge of a 'powder boss' who determines the amount of powder to be used and supervises the loading. All firing is done by electricity and all possible precautions are taken to prevent misfires; the wiring and shooting are done by an electrician and his gang, who are responsible for this part of the work. Dynamites of 45 and 65% strength are used almost exclusively. All holes are sprung before being shot, and usually they are sprung several times. At one place where I observed the work in a comparatively soft shale, the pioneer-cut

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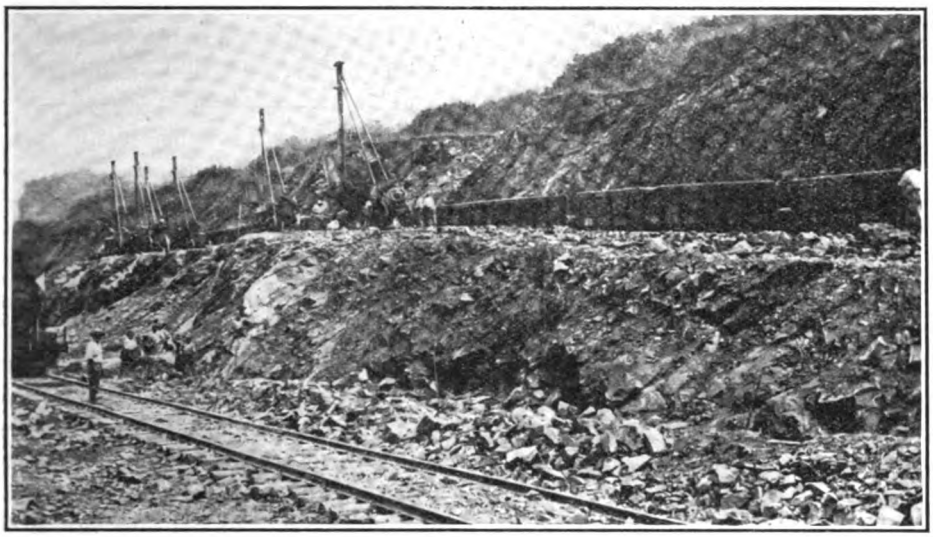
holes were being sprung twice, first with 1½ lb. of 60% dynamite, then with 5 lb., and a final charge of 20 lb. used in the centre rows and 15 lb. in the outside rows. It is quite probable that this charge would have been sufficient for a considerably harder rock.

The deeper holes are sprung four or five times, and some of the 30-ft. toe holes in hard rock are sprung six times and finally charged with 150 lb. of dynamite. A push-down battery is used for firing the springing shots, but for firing the final charges a 110-volt lighting circuit is used with the holes connected in parallel. The wires carrying



BEFORE SHOOTING A ROUND OF TOE-HOLES.

AFTER SHOOTING A ROUND OF TOE-HOLES.

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this current run along the banks of the canal and at frequent intervals are connected into firing-boxes containing a switch. These boxes are kept locked, and, as a further precaution against an unauthorized person attempting to fire a round of shots, it is necessary to make two different connections before shooting, so there is little danger from this source. Every precaution is taken to prevent missed holes; the maximum number of holes fired at one time is 150, although it is uncommon to fire more than 100 at once. Since the adoption of the present firing system few

LOADING A ROUND OF SPRINGING SHOTS.

misfires have occurred, but before that when batteries were used they were not uncommon. The accompanying photographs show the men engaged in loading a round of springing shots. Note the long wooden poles used in lowering the powder into the holes.

Drilling.—Two types of drills are used, the well drills or churn-drills, and the ordinary compressed-air piston drills, known on the canal as tripod drills. The well drills are worked in batteries of six, as shown in the accompanying photographs, and are run by compressed air. The rate of drilling with the well drills varies from 20 to 75 ft. per day, depending on the kind of material, depth of holes, etc. Most of the drilling is done with the well drills, as they are more easily handled than the tripod drills in making deep vertical holes. When very hard rock is encountered these drills are too slow, and then the tripod machines are used. These machines are large piston drills of the tappet valve type, with 3¼ to 3⅝-in. cylinders. The tappet valve has been found most suitable for drilling these deep holes, as its positive movement insures a powerful return stroke which is essential when drilling a vertical hole 27 ft. deep. The rate of drilling varies from 20 to 30 ft. per day in hard rock for holes 27 ft. in depth and bottomed 2 inches in diameter. The accompanying photograph shows a group of tripod drills at work. Note the long piece of steel in the hands of one of the drillmen.

I was surprised at the class of labor employed on these machines, as they are practically all Jamaica negroes and the highest paid receive but 20c. per hour. Their skill, however, in handling these big machines is remarkable, and much credit is due the foreman for the patience that must have been necessary to develop these untrained negroes into skilled drill runners. In discussing this matter with the foreman, I was informed that many of these poorly paid men were the equal of many American drill-runners, and from a brief observation of their work I would judge such to be the case. When the work was first started drill-runners were sent down from the States and were paid good salaries for this work,

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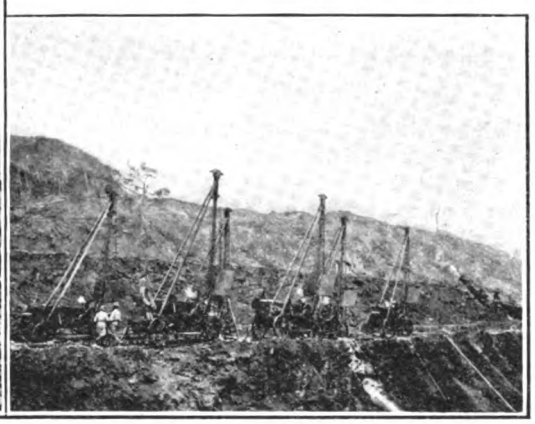
but they required two helpers and refused to do anything but crank the machines, so they were gradually displaced by this cheaper class of labor.

The work of taking down the slope or bank of the canal is done by drilling holes with tripod drills at the angle of the slope; these holes are placed close together and are met within one foot by other holes drilled horizontally into the foot of the bank, so that small charges of powder are sufficient to break the rock back to the slope without loosening the remaining material. The drilling of these slope holes is extra difficult and hazardous work, as the machines are mounted in some cases on a very narrow ledge of rock and perhaps beneath an overhanging cliff from which rocks are liable to fall. One of the few recent accidents was from this source, and three men were killed by a big boulder coming down upon them while they were engaged in drilling these slope holes.

AIR-DRILLS.



CHURN-DRILLS.

Cost of Work.—The following figures taken from the *Canal Record* of August 7, 1912, give an idea of the cost of the excavation work on the canal. These figures are the average for April, May, and June, and for a quantity of 4,386,000 yards:

	Per cu. yd.
Drilling	$0.047
Blasting	0.054
Loading	0.050
Tracks	0.065
Transportation	0.077
Dumps	0.023
Pumps	0.004
Maintenance of equipment	0.077
Plant arbitrary	0.030
Division expense	0.017
Administration	0.033
Total	$0.479

From the above figures it may be noted that the cost of the work is a trifle less than 50c. per yard, and of this amount the largest single item is that of transportation. The work of excavating the Culebra cut is not a question of steam-shovel capacity, for very few of the shovels are run to their maximum capacity; it is not a question of drilling or blasting; but the great problem is that of getting the cars to the shovels and away from them in the shortest possible time.

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The Engineering Digest

Richmond Harbor Improvements

[City of Richmond, California, has authorized a bond issue of $460,000 for an outer harbor and tunnel, and $710,000 for the inner harbor. The completion of this work will place Richmond in an exceptionally favorable position to claim a share of the expected large increase in ocean traffic. It is the terminus of the Santa Fe railway system and is tapped by the Southern Pacific as well. Haviland & Tibbetts, consulting engineers of San Francisco were retained by the city in regard to the plans for harbor improvements and it is through their courtesy that we are able to present an abstract of their report.—EDITOR.]

Outer Wharf, Division No. 1, Point Richmond Section

THE position of the proposed outer wharf in division No. 1 (Point Richmond section) is close to the Santa Fe wharves on the southern side of Point Richmond near the outer end. The wharf shed is to have its centre opposite and facing the proposed new roadway, whose outer end will be through a deep cut at Point Richmond. The wharf will parallel the U. S. Government bulkhead line with the outer line of piles at the extreme edge of the bulkhead line. The longitudinal axis of the wharf will then be parallel to the bulkhead, pierhead, and channel lines and normal to the outer end of the new roadway. It will be near the outer end of the government dike on the south side of the new channel and protected by the dike from the south storms. The area between the bulkhead and pierhead lines and out to the government channel line will be dredged in front of the wharf and at either end of the wharf along lines making an angle of 30° with the bulkhead line.

The proposed wharf will be at the extreme outer end of the proposed harbor developments, and will be the only bulkhead wharf in division No. 1 (the outer harbor area) between Point Richmond and Point Potrero. It is desired to provide immediate accommodations for the largest ships, as well as for smaller light-draft river boats. The bulkhead type of wharf, with its axis parallel to the shore line, as distinguished from piers with axis normal to the shore line, is best suited to the immediate and local needs. The government channel at this point is only 600 ft. wide, and as the proposed wharf is to be built at the extreme outer end of the channel and close to the end of Point Richmond, there will probably be tidal currents which will make it difficult to maneuvre large ships in the limited area. By using the bulkhead type of wharf it is possible to practically double the width of channel. The outer end of the wharf, which is designed to be used for river boats, will be set far enough back so that it will be partly sheltered by the Santa Fé wharves at Point Richmond. For the immediate future a single bulkhead wharf can be best designed, with suitable dimensions for the expected volume of traffic. In a bulkhead wharf the problem of providing sufficient storage room is more easily solved than with the pier type, because the entire area back of the bulkhead line for the full length of the wharf is available for storage and may be considered directly in touch with the water front. In the pier type only half the width of the pier can be considered available for temporary storage for a vessel unloading alongside.

The foundation material at the position chosen is shown by borings to consist of a deep layer of mud to a depth of 40 to 50 ft., or down to elevation minus 50 to minus 60. Under this is hard clay, extending to unknown depth. A single bulkhead wharf requires a greater length of sea-wall to be

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constructed than a single pier, but because of the hard underlying material, it is possible to utilize the bulkhead wharf for fixing the top of heavy sheeting, which will be designed to act as a sea-wall, retaining the mud so that a full depth of 30 ft. can be secured at the outer edge of the bulkhead pier.

The structure is 740 ft. long, divided into thirty-seven 20-ft. bays. The centre and ends have been treated as pavilions projecting 12 ft. in front of the face of the wall, and rising 5 ft. above the main cornice. The centre feature occupies five bays, the three centre bays being fitted with rolling lift doors, 16 ft. wide and 24 ft. high, surmounted by transom windows. The other two bays are treated with channeled pilasters 3 ft. 6 in. wide. Inside these pilasters are placed three-quarter columns with molded base and doric cap. Between these columns are placed two windows. The two ends of the building are treated in a similar manner, but occupy only three bays and have only one centre door. A portion of the building between the centre and end pavilions is divided into three sections, each section having three bays containing rolling lift doors, 16 ft. wide and 24 ft. high. Between each section are pairs of bays, each pair having a central rolling lift door 16 by 24 ft., and two side windows. The bays containing the side windows are 10 ft. wide, with long and narrow windows.

The cornice extends the entire length of the building at a uniform level, except at the centre and end pavilion, where it is raised 5 ft., and is finished with a blocking course placed on the top. Between the top of the metal doors and the cornice there are placed steel frame windows 16 ft. wide, with ventilating panels hinged at the upper side and 7 ft. long. The ventilating panels are connected with a pulley and cord for operating from the floor level. In order to break the monotony of the upper line of the windows, a blank wall is shown between the cornice and the doors at 10-ft. bays, carrying long narrow windows. The lighting area is about 15% of the total wall area and the ventilating area about 2½ per cent. The parapet wall is a 6-in. reinforced concrete slab, supported by reinforced concrete columns designed as extensions above the steel supporting columns of the roof. The cornice is to be built of metal lath and plaster on wrought iron forms. Ventilation is provided by means of centre pivoted sash 2 ft. 6 in. high by 6 ft. wide in the centre of each of the large windows over the doors.

The end elevations are divided into three bays, the centre bay having two rolling lift doors with dividing mullion. The other two panels have windows, the treatment being similar to the end panel on the side elevation. The centre doorway will be surmounted by a blank wall and will have a high cornice with horizontal top. Offices will be provided in each corner of the building to be utilized for employees, for temporary storage of special merchandise, and for fire protection equipment. The exterior walls will be finished in pebble dash, rough cast, except the cornice, which will have a smooth finish.

Special attention is paid to making the structures thoroughly fireproof, in order that there may be little risk to the city; that insurance rates may be a minimum, and that the danger from fire to cargo temporarily stored on the wharves, or to railroad rolling stock, or to ships alongside, may be made as small as possible. No combustible materials are used in the construction; material, such as steel, liable to be damaged by burning, and materials stored on the wharf are thoroughly protected by a covering of concrete. In addition to this, electric underwriters' fire pumps are installed in the building for pumping salt water from the adjacent channel, with a complete system of piping for fire fighting purposes, including Siamese hose connections both inside and outside the building in both front and rear at intervals not exceeding 100 feet.

The most serious problem in the design of the outer wharves is that of retaining the mud-fill back of the bulkhead line. In cases along the San Francisco water front, with foundation materials comparable, where piers are situated, and it has been necessary to construct an independent sea-wall, the cost has been from $150 to $200 per lineal foot. The design adopted for the proposed wharf consists of two parallel rows of heavy reinforced concrete sheet piling 12 in. thick, supporting the inner and outer edges of the wharf deck and designed to resist the lateral pressure of the mud and to retain it so that 30 ft. of water can be provided at low tide immediately off the edge of the wharf. The inner row of reinforced concrete sheet piling will be 40 ft. in length and will retain the

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mud-fill for a vertical distance of 10 ft., from elevation 10 to elevation zero. The outer line of sheet piling will be 60 ft. in length and will retain the mud-fill from elevation minus 20 to elevation of the channel alongside the wharf, which it is proposed at present to dredge to minus 24 ft., and ultimately to minus 30 feet. The corresponding depths of mud-fill to be retained by the outer row of sheet piling will be 4 ft. and 10 ft. Between the two lines of sheet piling the mud-fill will lie on a slope of one on 4½. The bearing piles underneath the main body of the wharf will also resist lateral pressure from the mud-fill, but this is depended on only as an additional factor of safety. The two lines of sheet piling will be tied together, and to the bearing piles of the wharf, by means of the wharf deck and by horizontal lines of struts at each pile-bent 13 ft. below the wharf deck, or at elevation zero. The sheet piling will be tied together longitudinally by reinforced concrete waling pieces placed in the plane of the lower strut system at elevation zero, and in the plane of the wharf deck at elevation 13 by the system of beams and girders. Each end of the wharf deck is also composed of reinforced concrete sheet piling. This method of construction will provide a continuous row of sheet piling around the periphery of the wharf, forming, with the reinforced concrete deck, an inverted box inclosing the mud slope underneath the wharf and perfectly protecting it from wave wash. The reinforced concrete sheet piles will be 12 in. square, reinforced with eight ¾-in. square bars and provided on each side with semicircular grooves, designed to be filled with cement grout after the piles are driven, thus insuring a watertight structure. They will be separately molded and allowed to thoroughly season before being driven. They are provided with a 2-in. pipe in the centre to facilitate getting them into place. The entire structure is to be built of reinforced concrete piles, beams, and slabs. The piles are spaced 10 ft. on centres in each direction, except under the railway track, where rows are placed directly under the rails and at the outer row of the columns supporting the shed, where the loads require two rows of piles, spaced 4 ft. apart. The bearing piles will be 70 ft. long and 16 in. square for the upper portion of their length tapering to 6 in. square at the bottom. They will be reinforced with eight ¾-in. square twisted bars set in a 12-in. circle and tied together with a helical wrapping of ¼-in. round steel wire. The penetration of the piling will be about 30 ft., which will take them well into the hard clay foundation material. The standard floor beams of the wharf deck will be 10 by 18-in. rectangular concrete beams, reinforced with five ¾-in. square bars. The beams carrying the railroad track and building walls, designed for heavy loading, will be of reinforced concrete 14 by 36 in. and 12 by 30 in., reinforced with eight ⅞-in. square bars and six ¾-in. square bars, respectively. All beams are to be designed as continuous, with rods running over the pile supports to provide for negative bending moments, and are to be reinforced for shearing stresses by bending up rods diagonally at the ends and by providing loops and stirrups. The floor slabs are to be 6 in. thick, of concrete, reinforced in each direction with ½-in. square bars on 9-in. centres. The paving will consist of 2 in. of fine graded asphaltic macadam or asphaltic brick, except for the space between and adjacent to the track rails on the outside, which will have wooden blocks on sand cushions, to permit of repairs or renewals to the tracks. The wharf deck beams and girders and piles are designed for a live load of 400 lb. per square foot. The car tracks are designed for Coopers E-50 loading.

The style of fender in ordinary use in wharf construction in San Francisco Bay consists of a line of untreated wooden piles driven into the mud at about 3-ft. centres, tied together with three lines of wooden ribbing, and connected with the wharf through car springs, set at short intervals, to absorb the vessel's impact. This type of fender involves a very heavy cost of maintenance, because the piles are rapidly eaten away by marine borers, necessitating complete renewal at intervals of six months to two years. The design of the Richmond wharf includes the hanging type of fender, such as is now being installed on the new San Francisco piers No. 26, 28, 30, and 32, consisting of steel triangles built up with 8-in. H sections hanging from the under side of the wharf beams in cast iron guides, which permit them to slip in and out in resisting the impact of the vessels. The vertical bar of each triangle carries three lines of wood ribbing, longitudinally. The lower is at the

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low-water surface and the upper at the wharf deck. This ribbing is bolted to 10 by 10-in. fender timbers spaced 2 ft. apart on centres and extending from a few feet below the low water to the deck of the wharf. Between the upper line of ribbing and the wharf deck strong car springs are set at intervals to absorb the impact. In the design for the Richmond outer wharf, the car springs are set at 10-ft. intervals and opposite the transverse pile bents. The steel triangles are set 10 ft. on centres as near to the transverse pile bents as possible, so there will be no bending moment in the horizontal beams. The maintenance is low, as the fender pile extends only a few feet below low-water, where the marine animals do little work, and also as the material required to replace the fenders is only about one-fourth of the length of driven piles. To prevent the hanging fender from being caught on the side of vessels moored alongside and torn vertically from the wharf, a raft of four 12-in. timbers should be floated against the fender piles at all times. This line keeps the vessel away from direct contact with the fender piles and prevents any stress being communicated to the fender line as the vessel rises and lowers with the changing tide.

The design of the outer wharf has been worked out to accommodate medium sized and light-draft river boats, as well as large deep sea-going vessels. The overall dimensions of the wharf are 801 ft. long by 91 ft. 3 in. wide. The outer 180 ft. nearest Point Richmond is especially equipped for river boats, and the balance is provided with a railway track and designed for use by large vessels.

The wharf shed is set 18 ft. 2 in. back from the front of the wharf on the bulkhead line, and is 72 ft. 4 in. wide and 742 ft. 4 in. long over all. The railway track goes on the wharf at the inner or easterly end and extends a distance of 620 ft. along the wharf in front of the shed. The entire shed floor is available for storage, freight handling, and teaming. Teams can come upon the wharf deck at either end of the shed and pass into the shed at the ends, or can pass along the outer side of the shed, if the railroad track is clear. By means of temporary inclines, teams could enter the shed at the centre or at any other convenient point. The elevation of the deck of the wharf is about 13 ft. This makes the inner side of the wharf 3 ft. above the street level and permits of easy loading of drays or wagons, or freight cars running along the track at the rear. A railroad track on the side street is close to the wharf, and is partly covered by a metal awning, so that trucking may be readily accomplished direct from the wharf floor into cars. The 3-ft. depression of the street level below the wharf is intended as a mean of the most advantageous heights for railway cars and for drays which are 3 ft. 8 in. and 1 ft. 6 in. high, respectively.

On the westerly or outer 180 ft. of the wharf there are provided two inclined runways with aprons for the accommodation of river boats having lower decks. These runways will be built of reinforced concrete and provided with vertical lift aprons to accommodate any ordinary height of deck of the river boats. One of the runways will be 16 ft. wide and one 8 ft. wide. There is nothing, of course, to prevent river boats from using any other portion of the wharf, as it is not too high for any of the larger boats at any time, nor too high for any of the smaller boats at high tide. The aprons will undoubtedly prove a great convenience, however, as they will eliminate the necessity of using gang planks for trucking.

The wharf shed is a steel frame structure, 72 by 740 ft., with reinforced concrete roof slab and curtain walls. The steel frame is thoroughly tied together and braced in all directions. The roof is designed for a live load of 30 lb. per sq. ft., with a horizontal wind pressure on the sides and ends of the building of 20 lb. per sq. ft. The standard spacing of the columns is 70 ft. transversely and 20 ft. longitudinally. The transverse spacing permits of the unobstructed use of the wharf floor for teaming and freight handling. There are four pairs of 20-ft. bays, which have a centre column replaced by two columns with 10-ft. spacing, making one 20-ft. bay in the centre, flanked by two 10-ft. bays on each side. This special arrangement of columns is necessitated by the architectural arrangement previously described. The spacing of the roof trusses throughout the building is 20 ft. At the special bays having columns on 20 and 10-ft. centres, the roof trusses retain their constant spacing, being carried on longitudinal trusses over the doorways. The roof purlins are spaced 11 ft. 8 in. on centres and are composed of 15-in. 42-lb. I-beams. The 4-in. reinforced concrete roof

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slab rests directly on the steel purlins. The surface is a water-proof five-ply composition of felt, tar, and gravel. The roof trusses are of the Warren type, with verticals supporting the upper cords and carrying alternate purlins. The upper cord section is composed of two 6 by 4 by ¾-in. angles. All other members are built of double angle sections. The roof truss is to be fireproofed throughout with metal lath on wood furring and protected by at least 2 in. of concrete or cement plaster. It is possible that the recent development of the tool known as the 'cement gun,' by which cement plaster is shot with compressed air directly from a pipe on to lath, will make it possible to fire-proof the trusses and other structural steel members without the use of forms or scaffolding.

The main supporting columns of the roof are composed of 12-in. 84½-in. H. sections continuous from the floor to the eaves, and supporting in addition to the roof trusses a heavy crane rail bracket 24 ft. above the floor for the freight handling apparatus. The columns are supported on a heavy reinforced concrete girder which distributes their load to two piles spaced 4 ft. apart. The base plates of the columns are anchored into this girder. Each transverse bent consists of two columns and a roof truss. All members of the steel frame are to be thoroughly fireproofed with at least 2 in. of concrete outside of any steel. Longitudinal rigidity is given to the building by the X-bracing in six 20-ft. bays containing windows, and in the eight 10-ft. bays. The rigidity of the roof framing is supplemented by heavy fire-proofing on the roof trusses and by a 4-in. reinforced concrete slab. The doors of the side elevation are 24 ft. high and 16 ft. wide, and provided with rolling lift steel shutters, which open vertically and roll on a cylindrical drum, set immediately above the doors between the crane rail girder and the head of the door frames. This height permits the extension arm of the traveling crane to pass through the doorway and to load or unload through hatches in roofs of box cars and, of course, to handle any material loaded on flat cars at a corresponding height. The end frames have a doorway in the centre 18 ft. high and 22 ft. wide. These end frames are built in three bays, the centre bay being 30 ft. wide and two side bays, each being 20 ft. wide. The side bays have X-bracing extending from floor to roof and giving lateral rigidity to the building.

The wharf shed is to be provided with a 5-ton traveling crane spanning the full 70 ft. between the side columns and traveling the full length of the building. It is to be of the extension-arm type, with a carriage designed to handle material a distance of 12 ft. outside the building line on either side of the shed. The crane can run the entire length of the building and pick up a load at any point of the building and transfer it to any other point, or to any point within 12 ft. of either side of the shed. The crane will be operated by electricity and will be especially useful for loading cars, wagons, or trucks at any point of the building or in the street immediately at the rear of the building. The traveling crane can be easily duplicated at any time that conditions warrant. The vertical clearance under the crane bridge is 24 ft., providing about 14 ft. clearance under the loading extension of the traveler and giving ample height for handling any loads which are required, either in cars or trucks. The extension arms will make it possible to handle in either direction from cars, either on the depressed track at the rear, or on the level track at the front door of the wharf sheds.

For the present it is recommended that approximately the outer 550 ft., or slightly over two-thirds of the wharf, be built as described, without the traveling crane.

Inner Harbor Wharf

The inner harbor wharves proposed are at the extreme end of division No. 2, the branch of the government channel extending to Ellis landing and on the easterly side of the channel, that is, at the point nearest to the centre of Richmond. The marsh land and the shallow water in this vicinity are to be filled with material dredged from the government and other channels, and the street system extended down to the proposed bulkhead line. The position is extremely well sheltered, being protected by the Potrero hills from west and southwesterly storms, and being entirely in an enclosed inner basin. It will afford an especially good position or harbor for smaller craft. It extends close to the present industrial section of Richmond, and will undoubtedly be the means of developing the land lying between the wharf

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site and the centre of Richmond as an industrial and manufacturing centre.

Foundations are favorable at this point for the construction of a bulkhead wharf. The earth strata upon which the wharf must be built consists of a layer of mud, a few feet in depth, overlying hard yellow clay, with thin alternate strata of sand and gravel. The mud can be excavated beneath the wharf and a permanent sea-wall cheaply constructed. Two units of wharf shed will be constructed, identical in all respects. Each building will be 410 ft. long by 63 ft. wide. Each will be divided into seventeen bays 24 ft. wide. Each bay has a 3-ft. pilaster extending to the cornice. All except the two end bays are fitted with rolling lift steel doors 18 ft. wide by 24 ft. high. Above the doors and under the cornice are two molded transom bars, forming the division between the doors, the transom lights, and the ventilating panels. Transom windows over each door have steel frames with wire glass. Between the transom window and the cornice are narrow, rectangular ventilating panels of diamond-shape pattern. The cornice is horizontal and continues for three bays, breaking around each pilaster, and at every fourth bay it is carried around in a circular arch. At each fourth bay the ventilating panel under the cornice is also circular. The length of the building is such that there are four groups of three bays each, with the arch bays separating the groups and forming the ends of the building. The elevation facing the channel is in all respects similar to the rear elevation facing the street.

The end elevation of the building is divided into three bays. The centre one has two rolling lift doors, 11 ft. by 18 ft. 6 in. high and 11 by 22 ft. high. The larger door extends down to cover the opening formed by a depressed railroad track. The dividing bar between the two doors is movable. The two end bays contain large windows instead of rolling lift doors and are designed to provide office accommodations at each end of the building. One corner will be devoted to electrically driven underwriters' fire pumps. The entire building will be constructed of reinforced concrete and the exterior walls will be finished in pebble dash, rough cast, except the cornice, which will have a smooth finish. The architectural effect of the building is heightened by an open basin for smaller craft at the inner end, finished with an open balustrade and pedestal wall along the bulkhead line. This balustrade and wall is broken by four openings with stairways leading to floats for smaller craft.

All structural materials are steel and concrete, and all finishing materials designed for the greatest permanence and the minimum cost of maintenance or renewal. The substructure and wharf sheds are of reinforced concrete, thoroughly fireproof. No combustible materials of any sort are used. The structure is fitted throughout with piping for fire protection, connected with underwriters' fire pumps, electrically operated, and designed to pump salt water from the channel adjacent.

The over all dimensions of the substructure plan or deck are 87 ft. 6 in. wide by 1069 ft. long. Upon this deck, wharf sheds are to be built each 63 ft. wide by 410 ft. long, and set 24 ft. 6 inches from the edge of the deck, along the bulkhead line. The two sheds are separated by a space 200 ft. long in the centre and are each set 24 ft. 6 in. from the extreme ends of the wharf deck. Two railway tracks are provided, passing longitudinally through the length of the structure. One is level with the floor and placed on the open dock outside the shed along the water front. The other is depressed 3 ft. 6 in. below the wharf in order to bring car floors on the same level. It passes longitudinally through the structure, dividing the shed into two spaces, one having a clear width of 28 ft. 6 in. in the rear, and the other a clear width of 18 ft. 10 in. The railroad tracks are connected by turnouts from the centre of the wharf between the sheds to the main track along the water front street. The depressed track is to be bridged at convenient intervals by movable rolling platforms, which can be lifted by the cranes or by hand to permit the movement of cars.

The wharf is founded upon concrete piles 16 in. square, with a penetration into the hard clay strata of about 30 ft. Upon these piles is built a reinforced concrete deck supported on reinforced concrete beams and girders. The deck is a 7-in. slab of concrete reinforced in two directions with ½-in. steel bars on 5-in. centres and surfaced in the interior of the shed with paving, as described for the outer wharves. On the waterfront side of the shed the paving between the various rails is to be wood blocks

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on a sand cushion to facilitate removal of the track rails. The piling plan shows rows of piles spaced 12 ft. apart longitudinally, and from 5 to 12 ft. transversely. The main building columns, which are 20 ft. apart, are each carried on four piles on 5-ft. centres, longitudinally, and 10-ft. centres transversely. The railway track inside the shed is carried on 3 pile bents. The railroad track and the portal pier crane tracks outside of the shed have piles at 12-ft. centres under each rail. All reinforced concrete piles like those of the outer wharf are to be 16 in. square for the upper three-fourths of their length and taper to 6 in. square at the bottom. They are to be reinforced with eight ¾-in. square twisted bars set on a 12-in. circle and wound with a helical rapping of ¼-in. round steel wire. The beams are to have brackets at the pile supports in order to increase the strength and rigidity of the connections. The elevation of the highest point of the finished wharf floor is to be plus 12 ft. In order to secure a pile penetration of about 30 ft. in the hard substrata this will require 70-ft. piles in the outer rows and 40-ft. piles in the inner rows next to the wall.

The sea-wall is to be a reinforced concrete retaining wall, supported and held by the inner edge of the wharf floor and founded on wood piles. The bottom of the wall is to be at a depth of 7.8 ft. below datum and will rest on a hard clay substrata. The slope of the earth from the base of the sea-wall to the channel bottom at elevation minus 20, will all be in hard clay and will be finished at a slope of one on two and two-thirds. The length of the piling is designed to provide for the ultimate excavation of the channel to a 30-ft. depth at low water. The slope will be constructed so that it can be extended at the same angle to the 30-ft. depth line. The fill back of the wharves will be finished at elevation 10 and will be retained by the concrete wall and the earth slope under the wharf. This slope will be paved with 3-ft. rip-rap extending underneath the wharf, and in front of the sea-wall through the small boat basin at the inner end. The concrete sea-wall is to be extended on the inner or city end of the wharf a distance of 300 ft., surmounted by an ornamental balustrade. Four stairways will descend from this wall to landing stages or floats, providing accommodation for tugs or small boats. The paved slope will permit of boats with a draft not exceeding 10 ft. at low water using the floats. The maximum load to be carried by the reinforced concrete piles will vary from 30 to 45 tons, depending upon their position under the wharf. The length of piles is intended to maintain safe bearing capacity, even when the channel is dredged to 30 ft. in depth and the earth around the outer lines of piles removed. The designing loads are the same throughout as for the outer wharf.

The exposed front of the wharf, at which vessels will tie up, is to be protected from impact by hanging fenders, similar in design to those described for the outer harbor wharves, except that the triangular frames and cast iron guides will be spaced at 12-ft. intervals instead of 10.

Each of the two wharf sheds are identical in structure. The plan shows columns spaced 61 ft. centre to centre transversely and 24 ft. centre to centre longitudinally. The columns have a cross-section of 14 by 24 in. with pilasters on the outside 36 in. wide and 2 in. deep. These columns carry the roof loads and the loading from the crane rail girders. They have a constant cross-section from floor to roof. They are reinforced with four structural steel angles 3 by 3 in. by $^5/_{16}$ in. laced together on the four sides. The design permits of a good bracket being made for the crane rail girder by means of a batten plate and also permits a reliable connection to the reinforcement of the lower chords of the roof girders, which reinforcement also consists of four steel angles laced together on the four sides. The crane rail girder is supported on a concrete bracket with two batten plates riveted to the steel angles of the columns.

The main girders carrying the roof are 6 ft. deep at the ends and 8 ft. 6 in. deep at the centre and 12 in. wide. These girders carry purlins 10 ft. 4 in. on centres and spanning 24 ft. from centre to centre of girders. The purlins are reinforced concrete beams 10 by 20 in. in cross-section, reinforced with three ⅞-in. square bars. They carry a 4-in. concrete slab reinforced with wire mesh. This slab is water-proofed on top, with a composition roofing of 5-ply felt, tar, and gravel. The walls of the building between columns and doors and window headers are to be 6 in. thick, reinforced with ⅜-in. square bars 18 in. on centres both ways. The window sash is to be built of steel, requiring the

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minimum of width in the wall. The doors are 24 ft. high and 18 ft. wide and are to be provided with rolling lift steel shutters, which open from a cylindrical roll on a drum set immediately above the door between the crane rail girder and the door head.

The rigidity of the building laterally is insured by the 24-in. depth of columns and the deep reinforced concrete girder with brackets at the column supports. For rigidity in the longitudinal direction, the purlins, the door headers, and the crane girder in each bay and the two solid bays which have no door openings are depended upon.

The lighting of the interior is accomplished by means of the windows in the wall. This window area is about 10% of the total wall area and will give good light when all doors are closed. Ventilation of the interior when the doors are closed is provided by means of open ventilators above the window and under the roof in the side walls. The area of the ventilators is about 3% of the total wall area.

In plan, the wharf deck has three tracks: two railroad tracks and one portal pier crane track. One railroad track and the portal crane track are outside the shed on the wharf deck next to the channel. These tracks are level with the wharf deck. The other car track, inside the shed, is depressed 3 ft. 6 in. below the floor so as to permit trucking on a level between the wharf floor and the car floor. This depression for the track is 11 ft. 8 in. wide and divides the shed into two areas, the one next to the street being 18 ft. 10 in. wide and the one next to the water side 28 ft. 6 in. wide inside of columns. The floor of the wharf is 22 in. above the street level at the building line, providing for level trucking from drays to wharf floor. It is intended that teams shall come upon the wharf deck at the two ends, and in the centre between the sheds, giving an entrance to the shed from both ends to the floor section, which is 28 ft. 6 in. wide. When the portal pier crane permits, and the outer car track is clear of cars, teams may also pass along the outside of the wharf shed from end to end.

Provision is made for a 5-ton traveling crane, with arms that can be extended laterally through the doorways and a distance of 12 ft. outside of the building line. This crane can run the entire length of the building and pick up a load at any point therein, and transfer it to any other point in the building, or to any point within 12 ft. of the shed line on either side through the doorways. This will provide crane service to freight cars on the depressed track in the building, to freight cars on the surface track on the water front side of the building, and to teams on the street side of the building. It is intended that the cranes shall be operated by electricity. The portal pier crane, which will run the entire length of the wharf for a distance of 1000 ft., is intended to load and unload vessels which do not have their own freight handling equipment in the shape of derricks and winches and to transfer this freight to freight cars on the track underneath it or to the wharf deck, where it can be picked up by the extension arm of the inside traveling crane.

For the present it is proposed to build only one of the two wharf sheds described and one-half of the total substructure, including one-half of the small boat basin and none of the mechanical freight handling apparatus.

Unit estimates have been made from a careful study of the costs of similar harbor work in San Francisco Bay. Some of the unit values are as follows:

Clam shell, dredging work, 10c. per cubic yard.

Suction dredging work, 6c. per cubic yard.

Rip-rap slope facing, $1 per cubic yard.

Reinforced concrete piling and sheet piling, $1 to $1.20 per lineal foot in place.

Untreated timber piling, 40 to 50c. per lineal foot in place.

Creosoted timber piling, 60 to 70c. per lineal foot in place.

Creosoted timbers and sheet piling for bulkheading work, $50 per 1000 board feet in place.

Bolts and spikes for bulkhead work, 3c. per lb. in place.

Reinforced concrete, in beams, slabs, and girders of wharf decks, $10 per cubic yard in place.

Concrete sea-wall, $10 per cubic yard in place.

Steel reinforcement for concrete, $65 per ton in place.

Asphalt paving for wharves, 10c. per square foot.

Hanging fenders, $13 per lineal foot.

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Wood block paving for wharves, 27c. per square foot.

Structural steel in wharf sheds, $80 per ton in place.

Steel rails, $50 per ton in place.

Rolling steel shutter doors, $1.10 to $1.25 per square foot.

Gravel roofing, 7c. per square foot.

Portal pier crane, $12,500.

Seventy-foot traveling crane, $9000.

Sixty-foot traveling crane, $8000.

All estimates include an allowance of 10% for engineering supervision, legal fees, and contingencies.

ESTIMATED COST OF ULTIMATE DEVELOPMENT OF INNER HARBOR.

Division No. 1—Between Point Richmond and Potrero.

11 piers, 160 by 750 ft. each, with 300-ft. slips, reinforced concrete and structural steel structures, thoroughly fireproofed, including sheds, mechanical freight handling equipment, sea-wall, and dredging of slips at $505,470...	$5,560,170
Belt line railroad with water front street	133,000
Outer bulkhead wharf and shed as shown in detail	387,000
Acquisition of land	50,000
Total for Division No. 1	$6,130,170

Division No. 2—Ellis Channel, including Point Potrero.

87½ by 500-ft. bulkhead wharves	$3,356,000
Cut or tunnel through Potrero hill	128,000
Belt line railroad with water front street	294,500
Outer bulkhead wharf and shed as shown in detail	387,000
Acquisition of land	17,800
Total for Division No. 2	$3,796,300

Division No. 3—Inner Harbor Section.

21 piers, each 160 by 600 ft., with reinforced concrete substructure and sheds, fireproofed throughout, including construction of sea-wall and dredging of slips, at $392,260	8,237,460
Belt line railroad with water front street	294,500
Acquisition of land	100,000
Total for Division No. 3	$8,631,960
Grand Total for Divisions No. 1, 2, and 3	$18,558,430

COST ESTIMATE FOR HARBOR IMPROVEMENTS PROPOSED UNDER PRESENT BOND ISSUE.

This estimate includes the acquisition of 802 acres of land, the construction of 14,900 lineal feet of temporary bulkheading, the construction of approximately 545 ft. of the outer wharf, and the construction of one unit of inner wharf.

It does not include the mechanical freight handling apparatus for either the outer or inner wharves. The estimated cost of the proposed improvements is as follows:

Bulkheading	$155,200
Acquisition of land	158,000
Outer wharf	270,500
Inner wharf	145,800
Total	$729,500

Care and Operation of Transformers*

By W. M. McCONAHEY.

THERE are two essentials to be considered in the design of transformers, namely, insulation and heating. There are other points to be taken into account, such as efficiency, regulation, adaptability to various classes of service, etc., but the only practical effect they have is to modify the proportions of the design.

The principal insulating material used in transformer manufacture, known as 'press-board' or 'fuller-board,' is of a fibrous nature. It is made up in large sheets varying in thickness from a few mils to about one-eighth inch, although in large transformers it is generally not used in thickness of less than $^1/_{16}$ inch. It is cut and formed into the proper shapes and assembled with the coils so as to give the necessary dielectric strength

*Abstract from *Electrical Journal*, Nov., 1912.

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in the various parts. From this it is seen that the fuller-board is depended upon to furnish the insulation between the various parts of the windings and between the windings and ground, and that it must be maintained in good insulating condition if the transformer is to have long life and continue to operate without giving trouble. Since fuller-board is of a fibrous nature, it has a tendency to absorb moisture. No satisfactory method has yet been devised for treating the fuller-board so as to make it entirely impervious to moisture, or has any satisfactory substitute been found that will meet the requirements. It is necessary, therefore, in order to protect the insulation, to use such means in operation as will prevent as much as possible the entrance of moisture into the transformer case and to remove any that may enter, before it has had time to cause serious trouble.

Formerly it was customary, in shipping transformers, to pack them separately from their tanks. When shipped in this manner it was practically impossible to prevent the insulation from absorbing moisture, even when special methods of packing were resorted to. Such schemes as packing in tin-lined cases or placing calcium chloride inside of packing cases never proved satisfactory, so that before putting transformers into service it was nearly always necessary to dry them out. This required time and care and a certain degree of expert knowledge which made it very desirable that some method of shipping be devised which would make it unnecessary to dry them out before installing. This is now accomplished by bracing the transformer securely in its tank, filling the tank with oil, and shipping in this manner. The only limit imposed upon this method of shipment is the inability of the railroads to handle very large sizes because of insufficient clearances. This has been overcome to a considerable extent by the use of a special form of 'drop frame' car with the floor much lower than that of an ordinary flat car.

When a transformer is shipped in its own tank with the oil it should arrive at its destination with the insulation and oil practically dry and free from moisture. In order to make sure of this, however, it is best to draw a few samples of oil from the bottom of the tank and test them. The best way to make the test is to use some standard form of testing cup and a variable ratio testing transformer by means of which the voltage can be raised gradually. The cup is filled with a sample of the oil, the gap is adjusted to a fixed length with a micrometer screw and the voltage is raised until a spark jumps across the gap through the oil. It is customary to set the gap about 150 mils, and with such a setting good oil will show a break-down insulation strength of not less than 30,000 volts, that is, 200 volts per mil of gap for an average of ten tests. A variable ratio testing transformer may not always be available, but no company using transformers should be without an oil-testing cup. If no means of varying the voltage is at hand, so that it is necessary to use a fixed voltage for making the test, the gap should be set to give 200 volts for every mil of separation, and break-down should not occur at this setting. In making tests in this way, however, it is not advisable to use a testing voltage below 6600 volts. If the tests on samples of oil as taken from the transformer, shipped in its tank with the oil, are satisfactory, it is a practically sure indication that the transformer is dry and ready to put into service.

Cleanliness is essential to good service, and it is important for the life of the transformer, particularly if it be of high voltage, that the tank be closed up tightly so as entirely to exclude dust and dirt. This is done by packing tightly around all outlet bushings and placing gaskets under the cover, and also under the hand-hole and man-hole covers. In very large transformers the gaskets are often made so that the tank can be made practically air-tight, but in medium and small sizes the gaskets are generally made of felt or hemp treated with a moisture-proof compound. It is surprising how much dirt can gradually work its way through a very small crack, so that it should not be taken for granted that small openings are harmless. To allow a transformer to operate with a loose-fitting cover or with openings not closed is inexcusable negligence which will be paid for by a shortened transformer life.

After the transformer has been installed and put in successful operation, a periodical inspection should be made about once every six months. Such an inspection should include a test of a sample of the oil drawn from the *bottom* of the tank and an examination of the interior. If a test of the oil

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shows the presence of too much moisture, or an inspection shows a deposit of dirt or slime in the transformer, the oil should be drawn off, filtered, and de-hydrated, and the transformer and interior of the tank should be thoroughly cleaned with dry clean waste. The ventilating ducts can generally be cleaned by squirting oil through them. If the transformer is water-cooled the cooling coils should be examined to find out whether any deposit has been formed on them by the oil. Some oils will form a coating on the cooling coils which acts as a heat insulator and results in the transformer running hot. This deposit can be removed only by scraping and rubbing the coils until they are clean. Good transformer oils will form little or no deposit. They are also reasonably clear, so that by the use of an incandescent lamp a very good inspection of the upper part of the windings can generally be made without the necessity and inconvenience of lowering the oil until the coils are exposed.

If the oil in a transformer is found to be dirty or to be forming a deposit, it should be filtered, and if it is found to contain moisture, steps should be taken at once to remove this moisture. The filtering process can be performed easily by passing the oil through two or three thicknesses of bolting cloth. One passage through the cloth will nearly always be found sufficient to remove all the dirt or deposit. The removal of moisture is not such an easy task. Various make-shift schemes have been tried, but all seem far from satisfactory. In order to remove the moisture completely and leave the oil in first-class condition, it should be passed through some standard form of de-hydrator designed particularly for the purpose. Probably the best form of this class of apparatus is known as the filter-press type. In this the oil is pumped through several thicknesses of a specially prepared paper. The paper has the peculiar property of allowing the oil to pass through freely, while at the same time retaining every bit of moisture until it becomes saturated. When the paper approaches saturation, it should be removed and replaced by fresh dry paper. This is the most successful method that has yet been devised for removing moisture from oil; it is very simple and removes the moisture entirely, leaving the oil in a clean dry condition. An exceedingly simple and satisfactory way of keeping the oil clean and dry is to connect a small de-hydrator outfit to a transformer tank in such a way that the oil can be pumped from the bottom of the tank through the de-hydrator and back again into the tank at the top. The connection at the bottom can be made through the oil-valve. The necessary connections can be made and the de-hydrator put into service without in any way interfering with the operation of the transformer. A small cheap de-hydrator having a capacity of about two gallons per minute can be had which is particularly suitable for this work. It can be kept in operation continuously until the oil is clean and dry.

The insulation of transformers is liable to absorb moisture either as a result of failure to keep them in the oil or as a result of the presence of enough moisture in the oil to greatly reduce its insulating value. In such cases it may be necessary to dry the insulation in order to prevent break-down. Proper measurements of the insulation resistance from the high-tension winding to the low-tension winding and to the core, and from the low-tension winding to the core, will serve as approximate means of determining its condition.

Insulation resistance measured with the transformer cold is nearly always much greater than when measured with it hot. Therefore, in order to determine the condition of the insulation, the transformer should first be heated by internal heat, or, preferably, by both internal and external heat, to a temperature of from 75 to 80°C. This temperature should be maintained for 24 hours. The insulation resistance may then be taken and, in general, it may be said that if it measures below about one megohm per 100 volts of transformer rated voltage, for example, about 100 megohms for a winding for 100,000 volts or above, drying out will be necessary. These resistance values are based on the assumption that the measurements are made when the transformer is heated. Unfortunately, this measurement is not ordinarily a convenient one to make, because of lack of the necessary facilities. The insulation resistance can be determined very easily with a 'megger,' but, as such an instrument is not generally available, the next best method is to use a direct-current voltage of 500 or 600 volts and a high resistance voltmeter. A special voltmeter having a resistance of about one

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megohm should be used, as the resistance of the ordinary direct-current voltmeter is too low to give very satisfactory results. With this method the voltage across the line is measured first, and then the voltmeter and resistance to be measured are connected in series across the line and another reading taken. The insulation resistance is then calculated from the formula

$$R = \frac{r(V-v)}{v}$$

in which R = resistance of insulation
r = resistance of voltmeter.
V = direct-current voltage across the line.
v = voltage reading with insulation in series with voltmeter.

By using a voltmeter such as may be obtained for such measurements, having a resistance of one megohm, the calculation is simplified, since r becomes equal to unity, and the above formula becomes

$$R = \frac{V-v}{v} = \frac{V}{v} - 1$$

Great care must be taken, in connection with all such insulation measurements, to insulate all wiring for the test, since resistances of several hundred megohms have to be measured. The best way is to use wires stiff enough to support themselves so that they can be run directly between the points to be connected without any intervening supports. When transformers are dried by the vacuum process, described below, the wires can be run into the case through the high-tension bushings which, when clean and dry, should have an insulation resistance high enough to prevent the readings from being appreciably affected. The voltmeter should be placed on a table that rests on dry well insulated supports. A double-pole, double-throw oil switch is preferable to an ordinary switch mounted on a marble base, because of the greater insulation resistance between the contacts in the former.

There are four principal methods of drying out the insulation of transformers: (1) by internal heat, (2) by external heat, (2) by internal and external heat, and (4) by the vacuum process.

Internal Heat.—With this method, alternating current is required. The transformer should be placed in its case without the oil and the cover left off to allow free circulation of air. The low-tension winding should be short-circuited and sufficient voltage impressed across the high-tension winding to circulate enough current through the coils to maintain the temperature at from 75 to 80°C. About one-fifth of normal full-rated current is generally sufficient to do this. The impressed voltage necessary to circulate this current varies within wide limits among different transformers, but will generally be approximately 0.5 to 1.5% of normal high-tension voltage at normal frequency. The end terminals of the winding must be used, not taps, so that current will circulate through the total winding. The amount of current may be controlled by a rheostat in series with the high-tension winding. As this method is slow and, at best, superficial, it should be used only with small transformers, and then only when local conditions prohibit the use of one of the other methods.

External Heat.—For drying with external heat, the transformer is removed from its case and a wooden box is built around it, with holes in the top and near the bottom to allow circulation of air. The clearance between the sides of the transformer and the box should be small, so that most of the heated air will pass up through the ventilating ducts among the coils and not around the sides. The heat should be applied at the bottom of the box. The best way to obtain the heat is from grid resistors, using either alternating or direct current. The temperature limits are the same as for the first method, using internal heat. The transformer must be carefully protected against direct radiation from the heaters. Care must also be taken to see that there is not inflammable material near the heaters, and to this end it is advisable to line the lower part of the wooden box with asbestos. The heater should preferably be placed in a separate box, the heated air being conducted to the bottom of the transformer through a suitable pipe. Where this plan is followed, the heat may be generated by direct combination of gas, coal, or wood, provided great precaution be observed not to allow the products of combustion to enter the box surrounding the transformer. However, heating by combustion is not to be advocated except where there is no source of electric power. This method, while effective, requires much longer than the following one,

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in which combined internal and external heat is employed.

Internal and External Heat.—In combining the two foregoing methods, the current should, of course, be considerably less than when no external heat is employed. This method is used occasionally where direct current only is available, a certain amount of current being passed through the high-tension winding only, as the cross-sectional area of the low-tension conductor is generally too large for it to be heated with an economical amount of direct current. The use of direct current for drying is not recommended except where alternating current cannot be obtained. In addition to being quicker than either the first or second method used alone, combining the two, results in the insulation being heated much more uniformly, which is obviously a great advantage.

Vacuum Process.—The vacuum process can be used only with the larger sizes of water-cooled transformers which have the cover bolted down over an air-tight lead gasket to a cast-iron ring riveted to the top of the case. In brief, it consists in placing the transformer in its case without the oil, closing the case air-tight, exhausting the air, and, by means of alternating current circulated through the coils, bringing the transformer to a temperature somewhat above that which corresponds to the boiling point of water at the reduced atmospheric pressure. Under a vacuum of 25 in., water boils at 55°C. With this process the transformer is dried thoroughly and uniformly, and at a low temperature, which reduces the risk of damage to fibrous insulation. It also allows the oil to be admitted to the case under vacuum, after drying, which effectually prevents the formation of air bubbles in the interstices of the windings and insulation. This is of great importance in large high-voltage transformers where it is necessary to have the oil entirely free from air. No definite time can be specified as that required for drying; it depends upon the condition of the transformer, its size and voltage, and the method of drying used. One to three weeks will generally be required. By plotting a curve of the insulation resistance measurements, for example, with *time* as abscissae and *resistance* as ordinates, the point where the insulation resistance begins to increase more rapidly may be ascertained by determining the knee of the curve. The total drying period should be about 115% of the time preceding the passing of this point.

If the initial insulation resistance be measured at ordinary temperatures, it may be high, although the insulation is not dry; but as the transformer is heated it will drop rapidly. As the drying proceeds at a constant temperature, the insulation resistance will generally increase gradually until toward the end of the drying period, when the increase will become more rapid. Sometimes the resistance will rise and fall through a short range one or more times before reaching a steady high point. This is caused by moisture in the interior parts of the insulation working its way out through the outer portions which were dried at first. As the temperature varies, the insulation resistance also varies, for which reason the temperature should be kept nearly constant and the resistance measurements should all be taken at as nearly the same temperature as possible. Measurements should be taken every few hours during the drying period, and the precaution should be observed of giving the apparatus constant attention.

As the drying temperature approaches the point where fibrous materials deteriorate, great care must be taken to see that there are no points where the temperature exceeds 85°C. Several thermometers should be used and they should be placed well in among the coils near the top and screened from air-currents. Ventilating ducts offer particularly good places in which to place some of the thermometers. As the temperature rises rapidly at first, the thermometers must be read at intervals of about one-half hour. In order to keep the transformer at a constant temperature for insulation resistance measurements, one thermometer should be placed where it can be read without removing or changing its position. The other thermometers should be shifted about until the hottest points are found, and should remain at these points throughout the drying period. Whenever possible the temperature should be checked by the increase of resistance method. When drying by the vacuum method, thermometers of course cannot be used, in which case the temperature of the transformer can only be determined by the increase of resistance method.

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Engineering Bonds

*Tax exempt in California.
†Legal investment for savings banks in California.
‡Available as security for deposit of state, county, and municipal funds and postal savings deposits.

THE SIERRA & SAN FRANCISCO POWER CO. has applied to the Railroad Commission for permission to purchase the Gold Mountain Water Co. of Tuolumne county for $27,500.

THE Railroad Commission has rendered a decision granting permission to the Mount Whitney Power & Electric Co. to issue bonds in the sum of $250,000. The money is to be used by the company principally for work on the Kaweah river. The Kaweah river project calls for an expenditure of approximately $1,250,000, and the proceeds from the present bond sales will be applied thereon.

RIVERSIDE WATER CO. has issued collateral trust 6% one-year gold notes to the amount of $597,500, dated October 1, 1912, in denominations of $500 and $1000. The notes are callable after April 1, 1913, at 100½ and interest. The city of Riverside has an option on the domestic system of the Riverside Water Co. extending until March 1, 1913, to purchase that part of the system for $575,000. This takes in only a small portion of the entire system of this company. There were $597,000 first-mortgage 6% bonds of the Riverside Water Co. outstanding and due October 1, 1912. The issuance of these notes is temporarily to finance the company by extending interest on the present bonds until the city's option has expired. If the city buys a portion of the plant for the sum of $575,000, the money thus received from the city, together with money which the Riverside Water Co. has in bank, will be used to retire these notes. If the city does not buy the property, then the Riverside Water Co. has a contract to sell $700,000 first-mortgage 6% bonds on all its property, and this money will be used to retire the notes.

The Riverside Water Co. has been in existence for 27 years, supplying about 80% of all of the water used in Riverside. This water is used over about 9000 acres of land, mostly under highly intensive cultivation, and the domestic system supplies the city of Riverside, which extends some 54 square miles.

The value of the system is estimated by competent engineers to be in excess of $3,000,000.

The earnings given for the year ended August 31, 1912, are as follows:

Gross earnings	$150,606.57
Operating, taxes and insurance	64,021.70
Net earnings	$ 86,584.87
Interest charges	32,276.34
Surplus	$ 54,308.53

SAN JOAQUIN LIGHT & POWER CO. first and refunding bonds recently approved by the Railroad Commission, to the amount of $320,000, will be offered for sale.

Earnings already published up to October 31 indicate the prosperous condition of this property. The officers of the company predict an even more rapid growth of earnings during 1913, largely based in the subdivision and irrigation, with power supplied by electric pumps, of many important ranches throughout the territory served by the company. Among such ranches which are now being subdivided or are being prepared for subdivision are the Sharon ranch of 30,000 acres in Madera county; the Chowchilla ranch of 108,000 acres in Madera and Merced counties; the James ranch of 72,000 acres in Fresno county; the Elkhorn ranch of 12,000 acres, near Wheatville; the Hacienda ranch of 15,000 acres in Tulare county; the Thornehill ranch of 4000 acres, north of Corcoran, and the Lerdo ranch of 7000 acres in Kern county. The operations of the San Joaquin company extend at the present time into 62 cities and towns situated in the seven principal counties of the San Joaquin valley, extending from Merced county on the north to Kern county on the south. Eliminating entirely sales of domestic water which is handled partly by subsidiary companies, the growth in light, power, and gas consumers is indicated by the following figures:

	At Consolidation, Aug. 1, 1910.	Jan. 1, 1912.	Oct. 31, 1912.
Light consumers	7792	12,162	14,206
Power consumers	450	864	1,287
Gas consumers	2555	4,090	4,724

The company's statement of physical property as of October 31 indicates an ownership of 332.3 miles of 60,000-volt transmission lines, 322.3 miles of 30,000-volt lines, and 1595 miles of distributing lines.

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Company Reports

The Riverside Water Co. has reported earnings for the year ended Dec. 1, 1912, as follows:

Gross earnings	$154,276.14
Operation, taxes, insurance	62,511.13
Net earnings	$ 91,765.01
Interest	32,138.84
Surplus	$ 59,626.17

The Union Pacific October reports for this and last year compare as follows:

	1912.	1911.
Average mileage	7,256	7,064
October gross	$ 9,687,570	$ 8,714,435
October net	4,761,324	4,440,428
Taxes	391,713	436,558
Net income	4,369,611	4,003,869
Four months' gross	35,006,002	32,191,461
Four months' net	17,326,892	15,677,036
Taxes	1,536,927	1,412,195
Net income	15,789,965	14,254,838

The Southern Pacific report for October 1912 compares with the preceding year as follows:

	1912.	1911.
Average mileage	10,307	9,933
October gross	$13,915,714	$11,925,129
October net	5,749,628	4,948,609
Taxes	478,829	403,381
Operating increase	5,270,799	4,545,227
Four months' gross	50,845,185	45,815,975
Four months' net	21,069,480	18,075,495
Taxes	1,886,067	1,596,750
Operating increase	19,183,413	16,478,745

The Great Western Power Co.—In a report to the executive committee, A. W. Bullard, vice-president, gives the following results of operations for the period Jan. 1, 1912 to Oct. 31, 1912:

	1912.	1911.
Gross earnings	$1,868,802	$1,592,969
Consumers	10,728	4,258
Load, hp.	120,500	94,892
Current, kw.	240,271,071	167,818,328

These figures show an increase of 17.31% in gross earnings, 152% in number of consumers, 27% in connected load, and 43% in current generated for the ten months ended October 31, 1912, as compared with the ten months ended October 31, 1911.

The Western Pacific has issued its earnings statement for October and four months, the income for the month applicable to interest on the first-mortgage bonds being $228,807.26, and for the period $685,052.00. At the rate of October income the Western Pacific would earn $2,745,687.12 for interest, or $245,687.12 in excess of the first-mortgage requirements. At the rate of income for the four months' period, the company would earn for interest $2,055,157.68, or $444,842.32 short of requirements. As the estimated gross earnings for November are $71,000 less than October's actual gross, indicating a decline in traffic with the approach of the winter season, it is hardly to be expected that the company will earn its full interest charges on its first-mortgage bonds during the current fiscal year, but it is quite certain that the sum saved for this purpose will be more than double the $800,000 earned for interest last year. While September and October were unusually good months, the showing in July and August was no better than last year, so it is probable that the company for the full fiscal year will do somewhat better than is indicated by the four months.

	Oct. 1912.	Oct. 1911.
Operating revenue	$632,031.55	$530,233.99
Operating expenses	381,825.78	415,888.40
Net oper. revenue	$250,205.77	$114,345.59
Outside operations	1,195.86	2,129.44
Total net revenue	$249,099.91	$112,216.15
Taxes	20,202.65	14,430.00
Oper. income	$228,807.26	$ 97,866.15

Four months ended October 31:

	1912.	1911.
Oper. revenue	$2,290,090.98	$1,990,089.39
Oper. expenses	1,525,081.90	1,452,392.43
Net oper. rev.	$ 765,009.08	$ 537,696.96
Outside oper't'ns.	253.88	11,560.59
Total net rev.	$ 764,755.20	$ 526,136.57
Taxes	79,702.64	57,400.00
Oper. income	$ 685,052.56	$ 468,736.57

Est. earnings for Nov. 1912	$561,000.00
Actual earnings for Nov. 1911	541,928.00

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Book Reviews

CITY OF LOS ANGELES, SEVENTH ANNUAL REPORT OF THE BUREAU OF THE LOS ANGELES AQUEDUCT, July 1912.

The letter of transmittal, over the signature of Mr. Mulholland, shows the progress made in the prosecution of this great work during the fiscal year July 1911-1912. According to the report, the footage was:

	Feet.
Open lined canal, excavated	21,520
Olancha and Alabama hills conduit, excavated	82,564
Covered conduit, excavated	90,264
Siphon trenching, excavated	52,589
Tunnels, excavated	8,504
Olancha and Alabama hills conduit, lined	69,152
Covered conduit, lined	100,301
Steel siphons	23,190
Concrete siphons	9,729
Tunnels, lined	63,785

Total excavation, 255,441 ft. or 48.38 mi.
Total lining, 266,167 ft. or 50.41 mi.

The amount remaining to be completed includes:

	Feet.
Olancha and Alabama hills conduit, excavated	48,025
Covered conduit, excavated	45,575
Siphon trenching, excavated	6,298
Tunnels, excavated	360
Olancha and Alabama hills conduit, lining	67,267
Covered conduit, lining	57,366
Steel siphons, lining	24,102
Concrete siphons, lining	2,495
Tunnels, lining	33,843

Total excavation, 100,258 ft. or 18.99 mi.
Total lining, 185,073 ft. or 25.05 mi.

Completed work in power tunnels in San Francisquito division includes:

Excavation	30,698 ft. or 5.8 miles
Lining	1,637 ft.
Haiwee by-pass	10,278 ft. excavated
Haiwee by-pass	10,278 ft. lined

Work remaining to be completed in the San Francisquito division includes:

Excavation	13,380 ft. or 2.53 mi.
Lining	42,441 ft. or 8.04 mi.

In perusing the text of this report, one is again reminded of the magnitude of the undertaking and the splendid and thorough manner of its accomplishment. Such progress has been made as to enable the chief engineer to place definitely March 1, 1913, as the date for its completion. In addition to the usual departmental reports concerning each section of the work, a chapter has been contributed by J. B. Lippincott, assistant chief engineer, on tufa cement as manufactured and used on the aqueduct. This chapter covers every detail concerning the manufacture, characteristics, and results of using this type of cement, and should make interesting reading for the critics who have attempted to discredit this portion of the aqueduct work.

STEAM ECONOMY IN THE SUGAR FACTORY. By Karl Abraham. Translated from the German by E. J. Boyle. John Wiley & Sons, New York. 96 pp.; index. For sale by the *Mining and Scientific Press*, San Francisco. Price $1.50.

The title is self-explanatory, as the text has been prepared for those interested or engaged in the sugar industry. American sugar producers will be greatly interested in the work done in Europe, and cannot fail to benefit from a knowledge of the practice employed outside of their own country. The economical use of steam is a factor of prime importance in the manufacture of sugar, by reason of its employment as an adjunct to nearly every stage in the process of manufacture. Beet sugar is the principal topic covered, the specific example upon which the work is based being the elaboration of white crystal sugar with two products, as it is carried on in Russia. A summary of the various stages in the process is given, followed by an exhaustive discussion of each stage, showing the various factors governing the economical use of steam and the means for obtaining the highest efficiency. Inserts are provided for making individual notes and observations.

AMERICAN CIVIL ENGINEERS' POCKETBOOK. Second Edition. Edited by Mansfield Merriman. 1400 pp., index. John Wiley & Sons, New York. For sale by the *Mining and Scientific Press*. Price $5.

This work needs no introduction to the engineering fraternity, as the first edition has won for itself a position in the reference libraries of civil engineers that has made it indispensable for the practice of this branch of the engineering profession. The first edi-

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tion was issued in December 1910, and was so favorably received that a reprint was necessitated three months later. The second edition of 15,000 copies contained two new sections, namely, section 14, giving the elementary principles of steam and electric engineering, which are of special value to civil engineers; and section 15, setting forth the most recent practice regarding the construction and maintenance of highways and streets. Eight new pages are added in section 2 on earthwork computations. Section 3 has been given over entirely to steam and electric railroads and seven pages of additional matter. Many other changes have been made throughout the text, bringing the subject matter up to the minute as far as developments in practice are concerned. Nothing of importance contained in the first edition has been eliminated, and there is no doubt that the second edition of this work will maintain the prestige of its predecessor.

TRANSMISSION LINE CONSTRUCTION. By R. A. Lundquist. McGraw-Hill Book Co., New York. 285 pp., index. For sale by the *Mining and Scientific Press*, San Francisco. Price $3.

High-tension power transmission has been the subject of much discussion from a technical standpoint, but, outside of such matter as has appeared in the technical press, there is no adequate work in existence dealing with the subject from the standpoint of the construction man. To say that it fills a 'long-felt want' would be only to repeat a hackneyed phrase, already greatly overworked by book reviewers, and yet there seems to be no other way of expressing the value of the data it contains. Costs of the various phases of pole-line construction are given at length, from the simplest and cheapest wood-pole, short-distance transmission to the most elaborate, steel-tower high-tension lines. The chapter on line location is excellent, and treats at length of the legal steps necessary to secure rights of way, giving proper form for conveying title under easement and suggestions for convenient forms for data required by construction foremen. Types of construction to meet various requirements are discussed and illustrated in full, with special attention to foundations, methods of setting and anchoring. The ordinary tools and appliances employed and their use are fully illustrated and described. Reinforced concrete poles are given a chapter by themselves, with a comprehensive treatment from the standpoint of actual practice in so far as this form of pole has been in use up to the present time. It is interesting to note the many examples of Pacific Coast practice cited in the book, showing by comparison that Western practice is fully up to the best types of construction to be found in the East.

THE MECHANICAL WORLD ELECTRICAL POCKET BOOK. Emmatt & Co., Ltd., Manchester. 240 pp.; index, diary 1913. For sale by the *Mining and Scientific Press*, San Francisco. Price $1.

This work has been compiled and is revised annually by the publishers of the *Mechanical World* of Manchester, England. The text comprises a collection of notes on electrical engineering with rules, tables, and general data. It is intended for electrical construction and manufacturing foremen, electricians, and mechanics, rather than for engineers. The publishers of this book are doing an excellent and useful work in the preparation of this volume. While there are countless technical books on electrical engineering, too little attention has been paid to the needs of the workman. Electricians and mechanics will find it a valuable aid in the course of their work, its size being such that it can be readily carried in a coat pocket.

SMOLEY'S TABLES, by Constantine Smoley. McGraw-Hill Book Co., New York. 174 pp. Index. For sale by *Mining and Scientific Press*, San Francisco. Price $3.50.

The seventh edition of this book covers parallel tables of logarithms and squares, diagram for solving right triangles, angles and logarithmic functions corresponding to given bevels, common logarithms of numbers, tables of logarithms and natural trigonometric functions, and other tables. If Kent's Mechanical Engineers' Pocket Book is entitled to be known as the engineer's bible, then Smoley's Tables is at least an engineer's prayer-book. That the great advantage of having all of such tables as are continually referred to in the course of engineering work inclosed within one cover has been appreciated by the engineering fraternity, is clearly shown by the demand that has necessitated six editions since the first issue of August 1901.

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Hints on Practice

RUST on iron or steel goods may be easily removed if the goods are first soaked in a hot caustic soda or hot caustic potash solution. This softens the rust, so that it is much more rapidly and effectually removed than by the acid pickle.

To drill chilled cast iron, first draw the chill. This is done by laying the piece on the forge, covering the spot to be chilled with sulphur, and working the bellows slowly until the sulphur is burned off. Then proceed with the drilling.

A NUMBER of experiments have recently been made which show that if iron borings are used in place of a portion of the gravel mixed in concrete, floors of this material can be successfully used in certain portions of foundries. Many foundrymen are interested in the use of concrete floors, but have generally found them unsatisfactory because molten iron will not lie on concrete on account of its porous, and therefore generally moist condition. The mixture recommended consists of 1 part cement, 3 parts sand, 4 parts gravel, and 1 part of iron borings. It is stated that floors made from this mixture are perfectly safe.

A NEW patent rust-proof coating for iron or steel is in the form of a paint that is applied to the surface of the article to be treated and is then baked. The following are the proportions of the ingredients by weight: linseed oil, 25 parts; calcium resinate, 36 parts; manganese borate, ½ part; sugar of lead, 1 part; naphtha, 37½ parts; artificial graphite, 25 parts. The whole is mixed and applied to the steel or iron by brushing, dipping, or other procedure. The article is then baked at 300°F. for a period of 1 hour and 40 minutes. It is stated that the coating is highly lustrous and is resistant to corrosive influences, but that no other form of graphite gives satisfactory results.

To coat copper pipes with a non-conductor, the following is recommended: First the pipes should receive one or two priming coats of potter's clay, mixed thin with water, and laid on with a brush. Then sifted sawdust is mixed with very thin starch, composed of two-thirds wheat starch and one-third rye starch. Then, before applying, a string is wound spirally round the pipes, keeping the spirals about two or three inches apart to secure adhesion for the first coat, which should be about one-fourth inch thick. After this coat is set, the second and third coats are applied, and so on until the required thickness is obtained. When dry, two or three coats of coal tar should be applied with a brush if the work is exposed to the weather.

To measure the clearance in an engine cylinder by actual test, the engine is carefully set on the centre, with the piston at the end where the measurement is to be taken. Assuming, for example, a Corliss engine, the best method is to remove the steam valve so as to have access to the whole steam port, and then fill up the clearance space with water, which is poured into the open port through a funnel. The water is drawn from a receptacle containing a quantity previously measured. When the whole space, including the port, is completely filled, the quantity left is measured, and the difference shows the amount which has been poured in. The measurement can be easily made by weighing the water, and the corresponding volume determined by calculation, making proper allowance for its temperature. The proportion required is the volume in cubic inches thus found, divided by the volume of the piston displacement, also in cubic inches, and the result expressed as a decimal. In this test, care should be taken that no air is retained in the clearance space when it is filled with water. The only difficulty in measuring the clearance in this way is that occurring when the exhaust valves and piston are not tight, and the water poured in, flows away and is lost. If the leakage is serious, no satisfactory measurement can be made, and it is better to depend upon the volume calculated from the drawing. If not too serious, however, an allowance can be made by observing the length of time consumed in pouring in the water; then, after a portion of the water has leaked out, fill up the space again, taking the time and measuring the quantity thus added, determining in this way the rate of leakage. Data will thus be obtained for the desired correction.—*Journal* Am. Soc. M. E.

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Engineers' Note Book

In storage batteries it is customary to allow a considerable excess of electrolyte beyond the chemical equations expressing the action. For central-station work, allow 10 to 20 lb. of electrolyte for 100 amp.-hr. of cell capacity. For automobile and similar work, allow 5 to 8 lb. electrolyte per 100 amp.-hr. capacity. On this basis the total weight of lead accumulators is:

Station work = 0.33 to 0.50 [capacity (ampere hours)] lb.

Traction work = 0.17 to 0.25 [capacity (ampere hours)] lb.

The Puget Sound Traction, Light & Power Co., at Seattle, Washington, recently experimented in coating with cement the piling in some of its trestle work along the shores of Ellicott bay on Puget Sound. This work was done under contract by the Butler Construction Co., of Seattle, the contract price being $4 per pile. The work consisted of concrete coating of 2½ or 3 in. thick, applied with a cement gun, covering the surface of the pile from a point 12 in. below the ground to a point 2 ft. below high-tide line. The concrete was reinforced with one thickness of wire mesh chicken fence netting. This work was done at low tide and in a section of trestle where piling has suffered rapid deterioration, owing to the action of teredos. Prior to this work a long section of the piling of this trestle had been concreted by use of forms, applied in the ordinary way without reinforcement. This work has been done at the cost of approximately $5.80 per pile. According to A. L. Kempster, the piling coated with the cement gun is apparently satisfactory in every particular.

The following cost of cresote butt treatment by the open tank method for wooden power transmission line poles is given by R. A. Lundquist:

Species.	Size of Pole. Top diam., in.	Size of Pole. Length, ft.	Amt. Creosote Applied. Lb. per cu. ft.	Amt. Creosote Applied. Lb. per pole.	Cost of Treatment. Preservative.	Cost of Treatment. Operation.	Cost of Treatment. Total cost.
Chestnut	7	30		25	$0.30	$0.45	$0.75
Northern white cedar	7	30		50	0.60	0.45	1.05
Western yellow pine	8	40	6	37.5	0.90	0.45	1.35
Western yellow pine	8	40	10	62.5	1.45	0.45	1.90
Western red cedar	8	40	6	39	0.90	0.45	1.35
Lodge pole pine	7	35		35	0.80	0.45	1.25

According to C. F. Wieland, the comparative analyses of Pocahontas coal and Kern crude oil are as follows:

	Pocahontas coal, %.	Kern crude oil 14.5 gravity, %.
Proximate analysis:		
fixed carbon	73.30	....
volatile matter	17.61	....
moisture	0.49	0.15
ash	8.60	....
Ultimate analysis:		
carbon	82.26	87.64
hydrogen	3.89	10.48
sulphur	0.49	1.02
oxygen	4.12	0.08
nitrogen	0.64	0.78
ash	8.60	....
sludge	....	....
Calorific B.t.u.	14,067	18,619

In steam-shovel work, from an operating standpoint, sand is an ideal material to handle, except when very fine and in heavy winds, in which case a high-pressure stream of water from a hose with spray attachment, if water be plentiful, will greatly help to keep the sand out of the eyes of the men. Sand in a freshly dug bank is quite often naturally moist.

We have found it an excellent method to weigh the amount of material that will fill a half cubic yard box, at average dryness, and then weigh several trains of cars of the material, which can easily and conveniently be done. From records obtained in 1898, average gravel used for railroad ballast, fair quality, moderately clean, weighed 3248 lb. per yard, rather dry, and the average flat car without sideboards contained 9.4 cu. yd. The length in a train of such average cars was 36 ft. centre to centre of couplers, so that when dumped from the train the ballast averaged 0.26 cu. yd. per foot of track. This was sufficient to raise one track 5 inches.—'Handbook of Steam Shovel Work.'

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Industrial Progress

The Lohmanizing Process*

In determining the true value of any process, it is well to first learn the characteristics, both good and bad, of similar methods. The coating of iron and steel, in order to protect it from corrosive action, such as rust and the influence of acid fumes, has been accomplished commonly by three well known methods: hot galvanizing, cold or electrolytic galvanizing, and with tin.

The effectiveness of a zinc coating has been proved to vary largely with the purity of the metal, its thickness, continuity, and the methods of application. In the hot galvanizing process, the original spelter is adulterated with lead, cadmium, iron, and other unrelated materials, which make it in reality an alloy from the beginning. Such an alloy will dissolve readily in acid solution because of local action which is not set up between the different adulterating metals and spelter. This results in a more rapid corrosion, than were a single metal immersed. Further, an excessive amount of scum which forms on top of the spelter bath makes the coating dirty and prevents the formation of an even and homogeneous layer. This makes the coating more susceptible at some points than others to the attack of any sulphurous atmosphere, such as that which is caused by coal smoke. This constitutes the first objection to the hot method of galvanizing. Then we find that acid in small amounts, is carried over from the pickle through the spelter bath, and, in the finished galvanized sheet is lodged between the base metal and the coating. This acid is in the form of chlorides which stimulate corrosive action even though they may not be the sole cause. Iron and zinc, plus iron chlorides and zinc chlorides may justify the name of galvanized iron, but such a combination must surely tend to hasten corrosion. Perhaps this last is the worst failing of hot galvanized sheets, for it is a sure cause of a separation between the zinc layer and base metal, such action being evident in zinc blisters, which eventually chalk, or crumble, leaving the metal exposed.

The weight of zinc coating must also be considered, for thin layers are to some extent porous, and in this condition, of course, do not faithfully shield the base. By increasing the thickness of the coating, the pores are gradually filled up, making less opportunity for centres of corrosion, but one can readily see that the thickness of coating might quite readily be made to vary with the spelter market. At the present time with spelter at six cents, it can safely be conjectured that many iron and steel sheets have porous coatings. But while we know the zinc coating should be heavy and pure, at the same time, when the least bit too heavy, the spelter cracks where the sheet is deformed. The two main points of objection to the hot process then, are: first, the inclusion, beneath the spelter coat, of acid from the pickling bath, which causes eruption and separation of the zinc from the sheet; second, while zinc to be effective must be in a heavy layer, at the same time its tendency to crack is increased in proportion to its thickness.

The greatest objection to the cold galvanizing process is the fact that on account of the coating becoming rough and crystalline after a certain thickness is reached, it is almost impossible to apply a coating having more zinc than approximately 1 oz. per square foot, while all government specifications for galvanized metal call for a 2-oz. coating. It has been stated that adherence of zinc to iron can be attributed to an alloying action which is supposed to take place. In testing for adherence, however, there is no indication of such alloying taking place in either hot or electrolytic galvanizing, for the tenacity of these coatings is very much less than would be expected if alloying existed.

Tin is practically non-corrosive, and therefore seems to be a logical metal for the protecting of iron and metal. The inherent objection to tin, however, is that, being electro-negative to iron, any exposure of the base metal through pin holing or rupture of the tin coating, results in an attack on the 'protected' material similar to the attack on positive poles in electric batteries. In this, tin is unlike zinc, for zinc, being positive in electrolytic action, protects the metal even while being destroyed itself by the force which makes it a protector. From

*These notes were furnished through the courtesy of the Brier Hill Steel Co., Youngstown, Ohio, which is licensee for the process.

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this characteristic there develops the greatest objection, perhaps, to its use, for it is very difficult to obtain an economical coating of tin so that it will not have fine pin holes all through.

This article has dealt primarily with the failings of well known methods of coating iron and steel with protective metals. Each of these processes, of course, has merits, some of which are distinctive, and may possibly indicate a special field of usefulness. But our attitude in covering this subject has been destructive, because in order to arrive at a true understanding of the strength of anything we must naturally discount its apparent strength by its native weakness.

Since the Lohmanizing process is new, a brief description of its chemistry may be interesting. Pickling by a sulphuric acid bath removes rust, scale, dirt, and the like, and prepares the metal for the Lohman bath, which, being composed of acid and amalgamating salt, further cleanses the pores and cavities, and deposits metallic salt upon the entire surface, penetrating the most minute pores and cavities. After the Lohman bath, the treated metal is dried, and then immersed in a molten alloy. An amalgam, or chemical union, is thus formed between the amalgamating salt and the protective alloy. Then the treated metal is gradually raised in temperature by the heat of the molten alloy which has a temperature itself of 950 to 1000° F. When the metal reaches a temperature of 500°, the amalgamating element volatilizes, is released and rapidly comes to and passes from the surface of the alloy. In its passage to the atmosphere the evaporated amalgamating salt frees the surface of the metal including pores and cavities, from all oxidizing agents. As the salt in evaporating empties itself from each tiny pore and crevice of the metal, protective alloy takes its place of course, and inasmuch as the base surface is clean, the alloy adheres thereto.

Therefore, the oxygen present in the cavities and on the surface, having a greater affinity for the amalgam element than for either the base metal or alloy, passes to the atmosphere, thus taking from the bath the minimum natural oxidizing agent, which is the cause of failure in other protective methods because of the fact that oxygen, in the usual processes, remains in some form between the treated metal and the protective metal and prevents a perfect bond.

By the Lohmanizing process, the protective alloy is made to become an actual part of the treated metal. This is proved by micrographs (microscopic photographs), which show a gradual shading from the original alloy to the base metal, indicating a deep permeation of the treated material by the protective alloy. Long slender tentacles of alloy have penetrated far into the base metal, filling up perfectly cavities of even the most minute character. A micrograph of a galvanized sheet shows a distinct line of separation between the zinc and iron; the zinc is a layer only. If the zinc on a galvanized sheet is cracked, or in any manner separated from the base metal, the bare sheet is exposed to corrosion at once, but if the thin outer coat of alloy on Lohmanized materials fractured, there still exists over the sheet a protective agency, the deep-seated alloy formed in the permeation of the treated metal by the protective metal, and this alloy cannot be fractured in ordinary uses without breaking the sheet itself.

It has been seen in galvanizing that while a heavy coat is necessary to good protection, at the same time the tendency of the spelter to crack increases with its thickness. The alloy coating on Lohmanized sheets withstands much greater strains than the galvanized coating, and while it may sometimes crack slightly on the extreme surface, such a condition will have no effect upon the durability of the coating. In the galvanizing we also learn that some of the pickling acid is sure to be included between the zinc and the base metal in the finished sheet, this acid agency finally causing a disruption of the coating, and exposure of the metal beneath. In the Lohmanizing process the amalgamating element, upon evaporation carries with it every vestige of acid or gaseous adulteration, leaving nothing to hinder the absolute blending of the alloy and sheet, and nothing to cause or abet concealed corrosive action at any later period.

We have seen that tin, while itself a logical protective metal, cannot be applied economically without being porous. The alloy used in the Lohmanizing process is homogeneous throughout and non-porous, for it accomplishes more than a coating, or layer; it results in an amalgamation, a blending or growing together, as it were, of the protected and protective elements.

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Engineering News

Power, Gas, and Electricity

San Francisco.—The Pacific Light & Power Corporation has applied to the Railroad Commission for permission to purchase the electric distribution system of the Eagle Rock Water Co. of Los Angeles county for $22,500. The Railroad Commission has granted permission to the Ojai Power Co. to issue stock to the amount of $250,000 for the construction and operation of an electric light plant in Nordhoff, Ventura county.——Permission has also been granted to the Fresno City Water Co. to issue bonds in the sum of $50,000 for the purpose of paying existing obligations and for extensions to its distributing system.——Report of the Northern California Power Co. shows the following gross revenue: Redding water system $23,940.50; Redding gas system $9457.15; Red Bluff gas system $9067.15; Willows water system, $14,954.72; Willows gas system, $7182.25; cost of operating these plants was as follows: Redding water works, $11,878.05; Redding gas works $4249.96; Red Bluff gas works, $4980.89; Willows water works, $7192.59; Willows gas works, $3942.20; the total gross income from the electrical system is reported at $642,331.53; expense of operation $71,303.03; maintenance and general expense, $312,106.27.——The Western States Gas & Electric Co., which is managed by H. M. Byllesby & Co., has applied for permission to issue $397,000 in bonds to pay off indebtedness and develop the system which supplies Stockton, Eureka, and other territories. This company is a consolidation of the Stockton Gas & Electric Corporation, the American River Electric Co., the Richmond Light & Power Co., the Humboldt Gas & Electric Co., the Eureka Lighting Co., and the North Mountain Power Co. W. W. S. Butler is vice-president and general manager.——The Board of Trustees of Stockton has granted to the Oro Electric Corporation a franchise to operate, distribute, and sell electric current in that city.——The State Railroad Commission has agreed to a proposal to organize a representative committee of engineers from all of the power companies, telegraph companies, and railroads consisting of 50 members in all to study and report on trouble due to induction on account of proximity of high tension transmission lines to telegraph and telephone lines. L. R. Thompson, engineer for the Railroad Commission, has the matter in hand.——The Edison Electric Co. commenced work on the extension of the lines west from La Canada through the Holmes Walton company's development to La Crescento and Sunland. Power is to be furnished for operating the pumping plant of the Holmes Walton Co.——Conferences are being held between a committee of the city council and representatives of the various companies operating in Los Angeles looking toward the purchase of a distributing system for power generated by the Los Angeles aqueduct. If these negotiations fail, the committee will urge the issuing of bonds for the construction of a municipal distributing system which, according to estimate of Mr. Scattergood, electrical engineer for the aqueduct, will cost $5,632,000.

Chico.—A contract has been signed by which the Northern California Power Co. will supply 20,000 hp. to the Oro Electric Co. to be used for the purpose of reclamation and irrigation of lands south of Chico near Sacramento which are owned and being developed by the Natomas Consolidated Company.

Dixon.—The Pacific Gas & Electric Co. has appropriated $60,000 for the improvement of its electric distribution system in Dixon.

Willows.—The Oro Electric Corporation has asked for franchise to operate in Glenn county.

Pomona.—An ordinance has been passed by the city council to extend the lighting system on several of the principal streets to serve districts in the residence section.

Winters.—Pacific Gas & Electric Co. has built a power line between Madison and Winters and the line between Dixon and Winters is being reconstructed. A line is to be built from Madison to Woodland.

Downieville.—C. J. York of the Downieville foundry has purchased the interests of William Dubuque and M. A. Costa in the Downieville Electric Co., thereby becoming sole proprietor.

Portland.—Announcement has been made by the Fleishhacker interests in connection with the Northwestern Electric Co. of Portland that the dam on White Salmon river will be completed by about the end of March. The company will develop 20,000 hp. at this point. The potential power of the White Salmon river is estimated at about 70,000 hp. With the auxiliary steam plant at

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Portland the company will have 30,000 hp. to dispose of.

Freewater, Oregon.—A branch electric line is under consideration from Freewater to Vincent. A. L. Rother of the Walla Walla Valley Railroad Co., is conferring with the Commercial Club of Freewater concerning this project.

Seattle.—The Puget Sound Bridge & Dredging Co. of Seattle has commenced construction of the dam on Jordan river, Vancouver island, for the British Columbia Electric Co. The dam will be 800 ft. long, 115 ft. deep, of the Ambursen type of reinforced-concrete construction. The amount involved is $500,000.

Caldwell, Idaho.—Setting of poles for the Beaver River Power Company transmission line from Boise to Caldwell is completed. The wire is expected upon the ground within a few days. Line voltage will be 44,000, the line extending from Boise through Meridian, Nampa, and Caldwell. A substation is to be built at Caldwell within a short time.

Salt Lake City.—Announcement has been made of the organization of the Utah Securities Corporation merging 17 power companies in Utah, Idaho, and Colorado. The properties acquired include the Telluride Power Co., the Knight Con. Power Co., the hydro-electric plant of the Davis & Webber Counties Canal Co., the steam plant of the Salt Lake & Ogden Railway, the steam plant of the Utah Copper Co., the Merchants Light & Power Co., and the properties of miscellaneous small lighting companies. The total generating capacity is approximately 60,000 hp. with 997 miles of transmission and distribution lines. Extensive developments and improvements will be undertaken in the immediate future to increase the capacity of the properties to 120,000 hp. The districts at present served include the mining operations in San Miguel and Ouray counties, Colorado, and all the principal mining districts in Utah including Bingham, Tintic, and Park City. Power for street railway and lighting service is furnished in Salt Lake and Ogden for interurban railway service between Salt Lake and Ogden, for irrigation pumping along the shores of Utah lake and elsewhere, and for retail lighting and power in 13 cities and towns in Utah, Idaho, and Colorado. The capital stock of the new company is $40,000,000. D. C. Jackling is president of the company, the headquarters are in Salt Lake City. G. E. Claflin of New York is vice-president and P. B. Sawyer of Salt Lake City is vice-president and general manager. The Ames and Illium hydro-electric plant in San Miguel county, Colorado, Olmstead hydro-electric plant and the Battlecreek hydro-electric plant in Utah county, Utah; the Jordan hydro-electric plant in Salt Lake county, Utah; the Logan hydro-electric plant in Cache county, Utah; the Grace hydro-electric plant in Bannock county, Idaho; the Davis & Webber Counties Canal Co., the Home Telephone & Electric Co., the Idaho Falls Power & Transmission Co., the San Juan Water & Power Co., and the Durango Gas & Electric Co. are also included in this merger.

Vancouver, B. C.—The International Railway & Development Co. has asked for a grant to develop a water-power site on the Chekamus river a few miles south of Green lake and a short distance from the proposed route of the Pacific Great Eastern Railway; 800,000 acre-feet of water is applied for from Green lake and its tributaries. It is proposed to deliver the water through a tunnel about 1 mile in length having a fall of from 100 to 150 ft. with a flow of 10,000 second feet. A power plant is to be erected in connection with the project. The estimated cost of work is about $2,000,000.

Irrigation and Water Supply

San Francisco.—The South Antelope Valley Irrigation Co. has petitioned the Railway Commission for permission to sell its water system in Antelope valley, Los Angeles county, to the Palmdale Water Co. for $75,000. ——The Commission has granted permission to the Sierra & San Francisco Power Co. to purchase the Gold Mountain Water Co. of Sonora, Tuolumne county, for $27,500.——The Redlands, Lugonia, Crafton Domestic Water Co. has applied for permission to sell its system to the city of Redlands for $225,000. The city by popular vote has decided to make the purchase and joins in the application.——The Little Rock Power & Water Co. has applied for permission to issue 3000 shares of its capital stock and $500,000 in bonds to provide funds for developing water rights owned on Little Rock creek in Los Angeles county.——W. W. Wilcox, D. Johnston, and O. L. Emery have applied for permission to sell a water system near Colton to the Clara Vista Water Co. The latter has asked permission to issue stock to the amount of $29,700 and $60,000 in bonds in payment.

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Stockton.—Land owners in the South Joaquin irrigation district will call an election to vote bonds in the amount of $1,170,000 for improvements in distribution and drainage system and additional bonds for $790,000 for the construction of a reservoir for storing 48,000 acre feet of water.

Richmond.—The voters have approved the creation of a water district to include, in addition to the city of Richmond, outlying territory extending to the Alameda county line.

Sacramento.—The West Sacramento Co., of which H. W. Furlong is chief engineer, is reclaming a large tract of land on the Yolo side of the Sacramento river.——The California Delta Land Co. capitalized at $12,500,000 has been formed to own and subdivide about 40,000 acres of land in the delta of the Sacramento and San Joaquin rivers. Lee A. Phillips and associates of Los Angeles are interested.——First carload of the shipment of 44,000 ft. of pipe to be used in connection with an irrigation plant at Citrus Heights near Fairbanks has been shipped by the Western Pipe & Steel Co. of San Francisco.

Loyalton, Sierra County.—The Morey Turner Co. of Reno, Nevada, will subdivide 65,000 acres of land and place it under irrigation.

Arbuckle, Colusa County.—A system of drainage ditches will be put in at Irrigation District No. 108.

Montague, Siskiyou County.—The Willow Creek route has been selected for the Shasta valley irrigation project. Symmes & Means, consulting engineers, of San Francisco, are in charge of the work.

Susanville, Lassen County.—The Snow Moody Development Co. of Salt Lake City has announced that work will commence soon on the Baxter creek irrigation project to furnish water for serving 18,000 acres.

Los Angeles.—Franchises have been granted to the San Gabriel Valley Water Co. and to the East Whittier Water Co. for developing water for irrigation.——The aqueduct board has reported that a loan of at least $300,000 is necessary for the completion of the aqueduct. A bond issue has been recommended.——The Western Pipe & Steel Co. has commenced to deliver 2½ miles of 12-in. pipe to the Holmes, Walton Co. A Byron Jackson centrifugal pump is to be installed. This work is part of a water works system to cost $150,000 which the company is installing for the development of the La Crescenta Canada district.——An irrigation plant to cost $150,000 for the irrigation of the Papago Indian reservation, nine miles from Tucson, Arizona, is planned by the Reclamation Service of the Department of Interior. C. R. Oldburg and F. R. Schanck are the engineers who have been conducting the investigation. ——The Aronson-Gale Co., H. W. Hellman building, Los Angeles, has completed plans for the construction of its 4,000,000-gallon reservoir at La Fortuna Farms. An electric power plant and pumps will be installed.

Pomona.—The American Sugar Co. has let a contract to Lon Fleming of Pomona for 18,000 ft. of large cement pipe for use in irrigating 13,000 acres of beet land.

Walla Walla, Wash.—A bond election is to be called early in 1913 for the purpose of authorizing a bond issue of $100,000 to provide for constructing a reservoir for city water supply.

North Yakima, Wash.—The Pacific Power & Light Co. will replace its wooden mains with iron and the intake ditch will be lined for eight miles with concrete.

Farmington, Wash.—A contract has been let to Foster & Hindle of Spokane for the construction of a municipal water system. The price is $7898. 9500 ft. of mains, a 100,000-gallon tank, and a pumping engine are to be installed.

Lapwai, Idaho.—A ten-year franchise has been granted to T. D. Barton for the construction and operation of a water works system.

Whitefish, Montana.—The city council has decided to install an extra pump at the pumping station.

Carson, Nevada.—Ira Winters will install an electric pumping plant at the southern border of Washoe lake for irrigation purposes.

Streets and Roads

San Francisco.—Bids have been received by the Board of Works for paving Geary street with bitumen from Buchanan to Divisadero, as follows: Flinn & Treacy, $17,254, City Street Improvement Co. $17,831. The finance committee of the Board of Supervisors will recommend that $18,000 be appropriated for doing this work of which $6380 is to come from the Geary Street Railway bond fund and $11,420 from the allowance for street repairs.——The city engineer has been authorized to prepare plans for a change of grade of San Bruno avenue at Army street.

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Oakland.—Alameda County Board of Supervisors are preparing plans for repairing the tunnel road from the inter-county tunnel to Bryant station. P. A. Haviland is county surveyor.

Sacramento.—The State Highway Commission has announced the selection of the Tejon Pass route for the proposed state highway between Bakersfield and Los Angeles. Kern county is preparing to issue bonds to the extent of $3,500,000 for road improvements to supplement the construction of the state highway. The route selected runs almost direct from Bakersfield to Saugus and is about 120 miles long.——N. W. Halsey & Co. have purchased $100,000 of state highway bonds from the State Board of Control.

Redwood City.—Plans for the new San Mateo county system of boulevards have been submitted to the Board of Supervisors by R. M. Morton, consulting engineer. The total length of roads to be built is 110.45 miles at a cost of $1,285,000 segregated as follows: Actual construction $1,069,822; culverts and bridges $100,000; rights of way $25,000; 8% for contingencies $95,586; total $1,290,408. It is expected that the report will be accepted by the Board and that the date for the bond election will be set in the near future.

Los Angeles.—Work on sections of the Ocean to Ocean highway between Mecca and Brawley and in the vicinity of Mammoth, will be commenced at once. The Los Angeles-Yuma auxiliary to the Ocean to Ocean Highway Association is carrying on the work and C. H. Bigelow is engineer in charge.——The Board of Public Works has let a contract for paving Los Angeles street, from Eighth to Twenty-third street, to Benjamin F. Ford, the price being $81,385.22.——A contract for paving Monte Vista street from Avenue 50 to Avenue 60 has been let to Fairchild Gilmore Wilton Co. at a price of $26,056.10. The work on Los Angeles street includes the construction of 12 culverts which will cost from $300 to $800 each.——Contract for paving and draining Sunset boulevard from Normandy avenue to Hollywood boulevard has been let by the Board of Public Works to the Barber Asphalt Co. at a price of $74,564.55. The paving will be asphalt and will include storm drainage. The time allotted for the completion of the work is 180 days.

Marysville.—The Yuba Consolidated Goldfields Co. has agreed to contribute $10,000 toward the construction of a macadam road between this city and Hammonton. Supervisor Morrison of the Wheatland-Hammonton district to contribute a like sum provided the supervisors amend the road ordinance in order to prevent hauling loads heavier than 3500 lb. over the Yuba county highways during the winter months.

Davenport, Wash.—Lincoln county commissioners have made a resolution to appropriate $36,000 for permanent highways. The Davenport-Harrington road will be macadamized from the city limits toward Davenport. J. L. Thayer is county engineer.

Walla Walla, Wash.—The Board of County Commissioners is planning the construction of 10 miles of permanent highways in Walla Walla county in 1913. Six miles of macadam road and 15 miles of gravel road were constructed in 1912. Plans for the coming year contemplate an expenditure of approximately $110,000 to be spent for roads and paving of all kinds, including $75,000 for the road districts in the county, while the mill tax levy now provided for will bring in $30,000; $5000 is available from the highway fund of the state now on hand. Five new steel bridges will be built, one across the Touchet river and four across the Walla Walla river.

Railways

San Francisco.—It has been announced that grading of the Oakland-Antioch railway will be entirely completed by January 13. The trestle across Montezuma slough is well under way and will be finished February 1. Four pile drivers are at work building the ferry slips on either side of Suisun bay. Contract for the construction of the section of road between Bay Point and Antioch will be let within the next few days. Concrete work in the Oakland-Antioch tunnel in the Berkeley hills is finished and the bore will be completed early in January.——Southern Pacific plans for betterments for 1913 include a new station at San Francisco to cost $500,000, a new station at Los Angeles to cost $750,000, a new station at Sacramento, plans to be announced as soon as franchise matters have been settled; double tracking between Omaha and San Francisco to be completed before 1915; various track betterments out of New Orleans and El Paso gateways on main line to southern California; completion of a through line on the west coast to Mexico City.——The California Rail-

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way & Power Co. has been organized in Delaware to acquire all of the outstanding capital stock of the United Railways of San Francisco, the San Francisco Electric Railroads, Sierra & San Francisco Power Co., and the Coast Valleys Gas & Electric Co. The new company has an authorized capital stock of $50,000,000 common, $10,000,000 7% cumulative preferred, and $5,000,000 prior preference 7% cumulative stock. The Sierra & San Francisco Power Co. is the reorganized Stanislaus project with control of the Mount Diablo Light & Power Co.——The Coast Valley Gas & Electric Co. is a merger of the Stanislaus Water, Light & Power Co., Monterey Gas & Electric Co., California Consolidated Light & Power Co., Monterey County Gas & Electric Co., King City Water, Light & Power Co., Salinas Valley Water Co., and Monterey & Pacific Grove Railway Co.—Plans have just been completed by the Key Route system for the construction of a 6-track pier from the shore of Oakland to the Key Route mole, a distance of 3½ miles at an approximate cost of $2,000,000. Spur and side tracks from the new 6-track pier to the district bordering on the municipal wharves and also from the present 14th street extension to the municipal wharves are to be constructed and the present train sheds are to be enlarged. It has been stated that the 6-track pier system is being built primarily with the view to accommodate the Oakland & Antioch railway.——A report is current that a branch of the Oregon Short Line is to be built from Twin Falls, Idaho, to a junction point with the Southern Pacific at Metropolis, Nevada. It is stated that this new track will serve as a link for a connection that will allow the Chicago, Milwaukee & Puget Sound Railway to send its trains to San Francisco.——R. E. L. Stephens of Dixon and A. C. Huston of Woodland have been elected directors of the Sacramento Valley Electric Railroad. It has been announced that construction of the road will begin within four months. Rights of way for 120 miles out of a total of 160 miles have been secured. C. L. Donohoe of Willows is president, E. L. Sisson of Red Bluff is secretary. A bond issue of $5,000,000 is planned.——A contract has been concluded between the W. L. Holman Co. and the Union Iron Works of San Francisco for the construction of 23 cars for the Geary Street Municipal Railway, the price to be paid is $7700 each, the money to be paid direct by the city to the Union Iron Works.——The Board of Public Works has awarded to Mahoney Bros. a bonus of $15,000 for the completion of the road bed of the municipal railway from 5th avenue to Kearny street ahead of time. The contract provides for $250 bonus for each day less than $180 allowed for the work, with the proviso that the total should not exceed $15,000. Mahoney Bros. saved 64 days in all or four more days than the number needed to entitle them to the maximum amount.

Richmond.—The city of Richmond has granted a franchise within the city to the Southern Pacific Co. for a new interurban electric line. The railroad company agrees to maintain a 5c. fare within the city limits and to pay 2% of the gross annual income of the road to the city at the expiration of five years. Freight hauling is permitted between 10 p.m. and 6 a.m.

Alameda. — The Southern Pacific Co. is building a new signal tower at Central avenue and 8th street which will be used for controlling the switching of the new Alameda-Oakland cross-town cars from the Alameda ferry slip to the cross-town line.

Placerville.—The branch line of the Southern Pacific Co. between Folsom and Placerville is to be improved by re-laying with 90-lb. rails.

Colusa.—Northern Electric Railroad has commenced grading the streets of Colusa. Material is at Meridian waiting for the completion of the bridge. It is expected that the grading will be completed within three weeks.

Marysville.—Construction work on the Northern Electric company's Marysville-Colusa branch is practically completed and a new time schedule has been arranged.

San Rafael.—A franchise will be sold on January 6 to the highest bidder for a new electric railway connecting San Rafael and San Anselmo and Fairfax, and providing a street car system for the city of San Rafael. The road will be operated by the storage battery system and will carry passengers only for the present.

San Jose.—The Peninsula Railway Co. has secured right of way through the creek lands of Berryessa and the work of rebuilding the electric line to Alum Rock park will be completed. A number of concrete bridges will be built. Gasoline motor cars are to be placed in operation between San Jose, Gilroy, and Palo Alto by the Southern Pacific Company.

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Woodland.—The Vallejo & Northern Railroad has applied for a franchise to construct a wharf along the Reed harbor property opposite Sacramento at an expenditure in excess of $50,000.——Petition of the Southern Pacific Co. for permission to construct a wharf at the point of Washington will be heard at the February meeting of the Board of Supervisors.

Modesto.—The Modesto-Empire Traction Co. line operating between this city and Empire, a distance of five miles, will be operated by storage battery electric cars.

Los Angeles.—The Los Angeles Electric Railway Co. is expending approximately $750,000 on betterments, including the building of three new cross-town car lines, aggregating 15 miles of a single track, and the purchase of 50 new cars for general service. —The City Council has granted the Pacific Electric Railway Co. a revokable franchise for handling freight on its line east of Main street.——The Santa Fe Railway Co. is planning to build a new railway station in Los Angeles at a cost of about $1,000,000.

Grants Pass, Oregon.—The voters have endorsed a bond issue of $200,000 toward financing a railway from this point to Crescent City, California. The business and lumber interests of Crescent City are reported to have subscribed for the same amount. Articles of incorporation of the Pacific Interior Railway Co. have been filed. The incorporators were George W. Calvig, E. T. McKinstry, and W. P. Quinlan. The project is to include 12 miles of logging railroad built by the Hobbs Wall Company.

Walla Walla, Wash.—The Pacific Light & Power Co. and the Walla Walla Valley Railroad Co. has announced that a sum of $150,000 will be expended in the Walla Walla valley for betterments in 1913, and if the 10-mile Vincent extension to the interburban line is built, it will involve spending $220,000 more. The work contemplated includes the construction of tracks in Walla Walla and Milton, new cars, paving, right of way over Clinton to Whitmore street and College avenue, new freight locomotive sheds, reconstruction of substation, and new passenger station at Freewater, and a mile extension of the Prospect Height's line as the first step to building a loop for the Foot Hill and Russell creek districts, connecting with the East Walla Walla line.

Vancouver, B. C.—The City Council has under consideration a proposal from the Canadian Northern Railway for the reclamation of the entire bed of False creek east of Main street from Westminster avenue. Through freight terminal facilities will be provided, which, with the cost of a tunnel for entering the city, will entail an expenditure of $8,000,000. Plans for development include: Expenditure of at least $4,000,000 in terminal facilities at the head of False creek, including a terminal station costing $1,500,000; construction of a retaining wall across False creek at Main street in front of the proposed fill, doing away with the present wooden bridge and leaving in its place a thoroughfare 200 to 300 ft. in width, including a parkway in front of the station; filling in False creek from Main street to its head, consisting of some 160 acres, the cost of which will be in the neighborhood of $1,200,000; dredging False creek west of Main street, with a 200 or 300-ft. channel, 20 ft. in depth, as far as is necessary to obtain the material for the fill; construction of a 4-mile double-track tunnel to bring the line into False creek at an expense of $4,000,000; reimburse the city to the extent of $600,000 for the purchase of certain riparian rights necessary for the project, permit other railways to use its facilities in the centre of the creek at reasonable rates, and indirectly to give other lines an opportunity of entering the city on its lines. The work is to be started within 90 days from the acceptance of the proposal and to be completed within 5 years. It is estimated that some 8000 men will be required on the work. Should the Canadian Northern Railway secure the consent of the city to its proposal for the development of False creek, it contemplates other extensive improvements, such as the erection of a large hotel on land other than that reclaimed from False creek; construction of terminal docks for the use of its proposed Pacific fleet of steamers; electrify all of its line within the city, including the tunnel; operate a suburban service between Vancouver, New Westminster, and Port Mann, giving the places named a 20 and 30-minute service, respectively; erect roundhouses and car-building shops at Port Mann, and other improvements at present not announced.

Mexico City.—The management of the National Lines in Mexico has appropriated $4,000,000 gold for the construction of a railroad between Tampico and Vera Cruz. The Compañia Constructura de Ferrocarriles has a contract to build 100 kilometres (62

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miles) of this road, and has had a large force of men at work on the same for the past six months. When completed, this road will open up one of the finest agricultural regions of the Republic, which has never been able to market more than a small part of its products. The railway will run through the heart of the oil belt and save the enormous expenditure of piping the oil to Tampico and then loading in cars to be shipped to Mexico City by a roundabout way. The road is being built on the old workings between Tampico and Mexico City and will cross the Tuxpam river about 45 kilometres (28 miles) west of Tuxpam. As soon as the branch to Vera Cruz has been completed work will begin connecting this road with Tuxpam and Mexico City.

Petroleum

California oil dividends for November were as follows:

Amalgamated	$1.00	$ 50,000.00
American Pet. pfd	.005	8,755.00
do common	.00 1-3	39,607.00
Caribou	.00 1-3	8,070.00
Central	.0075	7,500.00
Claremont	.01	5,000.00
Del Rey	.005	3,927.95
Empire	.40	80,000.00
Home	.01	5,000.00
Monte Cristo	.025	12,500.00
Mount Diablo	.015	7,500.00
New Pennsylvania	.005	5,000.00
Paraffine	.01	3,000.00
Record	.01	5,000.00
Republic	.12	60,000.00
S. F. McKittrick	.01	5,000.00
Sauer Dough	.0075	2,992.50
Section Twenty-five	.50	20,000.00
State Consolidated	.01	5,000.00
Traders	.006	9,000.00
Union Oil	.006	194,743.60
Union Provident	.006	91,402.02
United Petroleum	.006	48,450.60
W. K.	.02	10,000.00
Western Union	.005	5,000.00
Total Cal. Cos		$ 673,448.67
Mex. Pet. Ltd., pfd	.00 2-3	80,000.00
do common	.001	320,000.00
Grand total		$1,073,448.67

The Interstate Commerce Commission has authorized a rate of $5.76 per ton, carloads, on crude oil from Bakersfield to Garfield, Utah.

Production for all California fields for November was as follows:

	November Total bbl.	November Daily av.
San Joaquin valley:		
Coalinga	1,568,841	52,294.70
Kern River	854,923	28,497.43
McKittrick-Belridge	541,151	18,035.03
Maricopa	381,491	12,716.36
Midway	2,286,896	76,229.86
Lost Hills	117,882	3,926.06
Total San Joaquin Val'y	5,751,184	
Coast region:		
S.M.-Lompoc-Cat Canyon	421,937	14,064.56
Summerland	4,200	140.00
Total Coast Region	426,137	
Southern fields:		
Olinda-Brea-Puente	473,868	15,795.60
Salt Lake-Sherman	223,600	7,453.33
Whittier	54,527	1,817.56
Coyote-La Habra	145,464	4,848.80
Los Angeles City	31,842	1,614.00
Newhall	7,200	240.00
Ventura	62,370	2,079.00
Total southern fields	998,871	
Grand totals	7,176,197	239,206.56
Shipments	6,897,609	229,720.30
Losses	122,930	4,097.66
Total outgo	7,014,539	233,817.96

November surplus of production over outgo, 161,568 bbl.; daily average, 5388.60; same, October, 292,156 bbl.; daily average, 9424.39; decline in November surplus, 4035.79 barrels. The total consumption of field fuel in the state was 419,859 barrels and the gross production 7,596,201 barrels.

Field development for November was as follows:

Rigs—Coalinga, 6 new, 33 old; Kern River, 17 old, no new; McKittrick, 5 new, 22 old; Maricopa, 4 new, 24 old; Midway, 20 new, 51 old; Lost Hills, 3 new, 19 old; Santa Maria, none; Olinda-Brea-Puente, 1 new; Salt Lake-Sherman, 4 new; Coyotes-La Habra, 3 new; Ventura, 5 old; total, 46 new, 171 old.

Wells Deepened—Coalinga, 22; Maricopa, 5; Midway, 11; Santa Maria, 8; Olinda-Brea-Puente, 6; Salt Lake-Sherman, 5; Whittier, 2; Ventura, 1; total, 60.

Wells Abandoned—Maricopa, 1; Midway, 6; total, 7.

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FIELD CONDITIONS

	Month's Complet'ns. No.	Month's Complet'ns. Outp.	Producers. Act.	Producers. Idle.
Coalinga	8	210	875	183
Kern	4	40	1695	174
McKittrick	6	580	285	31
Maricopa	..	...	249	146
Midway	28	3560	720	161
Lost Hills	5	350	47	...
Santa Maria	3	575	232	46
Olinda-Brea-Puente	1	water	326	13
Salt Lake	3	300	288	8
Whittier	..	...	143	8
Coyote	1	150	13	...
Los Angeles	..	...	412	...
Summerland	..	...	125	25
Newhall	..	...	79	4
Ventura	3	390	307	27
Totals	62	6155	5796	826

SURPLUS ON HAND

	Field stks.	Pipe line.	Total.
Coalinga	330,496	2,631,924	2,962,420
Kern River	415,777	29,538,893	29,954,670
McKittrick	90,400	811,908	902,308
Maricopa	341,289	258,628	599,917
Midway	639,590	1,778,094	2,417,684
Lost Hills	19,750	185,304	205,054
Santa Maria	318,689	408,426	727,115
*Olinda	59,617	98,517	158,134
Salt Lake	111,829	35,037	146,866
Whittier	30,423	.....	30,423
Coyotes-LaH.	23,978	.....	23,978
L. A. district	15,000	246,008	261,008
Newhall	5,316	.....	5,316
Ventura	17,631	31,517	49,148
Outside p'nts	.....	8,726,867	8,726,866
Totals	2,419,785	44,751,124	47,170,909

*Olinda, Brea Canyon, Puente.

Gross production for 11 months of 1912 is:

1912.	Barrels.
January	7,576,076
February	6,951,449
March	7,275,004
April	7,210,000
May	7,335,000
June	7,327,830
July	7,436,684
August	7,592,335
September	7,580,985
October	8,125,514
November	7,596,201
Total	82,007,078

San Francisco.—A recommendation has been made by Fred Dennett, Commissioner of the General Land Office at Washington, D. C., in his annual report to the Secretary of the Interior, urging an extension of the scope of the postal laws to cover cases of misleading circulars regarding public lands. This measure is intended to put out of business professional locators who offer, for reward, to locate settlers and entrymen on desirable tracts of public land. ——It has been stated that the General Petroleum Co. and the Independent Oil Producers Agency have bid 35c. per bbl. at the well for oil below 18°B. which the Standard Oil Co. recently refused to accept. This is 5c. per barrel higher than the former prevailing price for this heavy oil.——The Union Iron Works has commenced construction of a steel stern-wheel steamer for the Standard Oil Co. It will be 100 ft. long, 28-ft. beam, and will be used as a tanker to replace the oil barges now used by the company to supply vessels in the stream and at the docks.——Timothy Spellacy, of the Oil Producers' Marketing Association, has predicted that heavy crude oil will be sold for 40c. per barrel in 1913, with the price increasing to 60c. per barrel within three years. The members of the Marketing Association have declined to accept 35c. per barrel and also will not make any contracts inside of 60 days.——It has been announced that the new oil refinery at Hanford, of which George W. Calhoun is superintendent and Philip Meyer is sales manager, will be ready for operation in January.——Frederick C. Dezendorf, chief of the field division of the U. S. General Land Office, has been notified that the Government has restored to entry and settlement petroleum reserves in township 16 south, 11 east, 17 south, 12 east, M. D M., and in San Bernardino base and meridian, township north, range 21, 22, and 23 west. Other lands restored are in township 14 south, ranges 12 and 13 east; township 17 south, ranges 13 and 14 east; township 26 south, range 26 east; township 27 south, range 28 east; township 28 south, range 28 east; township 27 south, range 29 east; township 29 south, ranges 29 and 30 east; and township 30 south, range 30 east, M. D. M. These lands will be open for settlement after January 30, 1913, and to entry after March 3.——Material for the new refinery for the American Oil & Refining Co. at Tulare has arrived, and construction work will commence at once. The capacity of the

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new plant will be 1000 bbl. of oil per day.

Auburn.—The Standard Oil Co. has commenced work on a new oil distributing station at this point. Storage tanks and other equipment will be installed.——Unconfirmed rumors report that John Hays Hammond, representing a British syndicate, has purchased 40,000 acres of land along the base of Mt. Hamilton and extending into San Luis Obispo county. This land is said to be strongly underlain with rich oil strata.

Los Angeles.—The American Gasoline Co., J. C. Van Eck, president, is contemplating the construction of a gasoline importing station in Los Angeles.——The Mexican Petroleum Co. is said to be about to increase its capital stock by $10,000,000.——The first payment of $500,000 has been made to the Union Oil Co. by the General Petroleum Co. toward consummation of the purchase, as reported in last month's issue; $100,000 is to be paid on April 1, 1913, and $100,000 every three months thereafter until $1,000,000 in all has been paid, when the buyers are to pay the balance of the purchase price, or $19,000,000. ——The Standard Oil Co. has received a contract for supplying the Monolith cement plant with fuel oil in quantities not exceeding 500 bbl. per day at the rate of 45c. per bbl.——The Mexican Petroleum Co. is building a gasoline-from-gas plant at the Huasteca property at Casiam. The capacity will be from 5,000,000 to 6,000,000 cu. ft. per day.——A committee of California oil operators, in connection with C. I. Parker, Collector of Internal Revenue for the Sixth California District, is preparing a new regulation by which all oil corporations may file their statement of net income with the Government as provided by the corporation tax law enacted in 1909. The new regulations, if approved by the Commissioner, provide that the oil companies, in arriving at their net income for any given year, may deduct from the gross income, as a depreciation, a certain amount per barrel for every barrel of oil produced during the year on which the report is made. ——The Asiatic Petroleum Co. is establishing a chain of distributing stations along the Pacific coast in order to market and handle the product of the Shell Trading & Transportation Co. T. P. S. Harris, of London, representing the Shell people, J. C. Van Eck of San Francisco, representing the American Gasoline Co., H. R. Gallogen, and H. L. Burleson are engaged in making plans for carrying out the details.——It has been announced that the Santa Maria Oil Fields, Ltd., has purchased the road-contracting business and treating plant of the John R. Ott company and is preparing to enter this field on a large scale. A plant is being completed on its property at Cat Canyon. The Trumble system will be used; road oil and asphalt will be manufactured.

Panama-Pacific Exposition

According to Charles C. Moore the following gives a summary of the amount of work that has been thus far accomplished for the Panama-Pacific Exposition: 130 buildings have been removed from the site; over 1,600,000 cu. yd. of earth has been filled in upon the ground; the service building is practically completed; general plans for the 14 exhibit palaces are ready; designs for statuary and general color scheme have been perfected. Contracts have been let for grading the entire site and for excavations for Machinery hall. A roadway is under construction from Ft. Mason to the Government docks. Contract has been let for the grading of the railway yards and for the improvement of Fulton Basin which is to be used for a yacht harbor. Arrangements are being made to fertilize the ground with 100,000 cu. yd. of Sacramento river loam. Twenty-two foreign nations have accepted the invitation of the United States to participate, Japan, China, Sweden, and Portugal have already selected sites. France has cabled for 12 acres. Thirty-two states have taken legislative action toward participation. Eighteen states have officially selected sites. New York has made a preliminary appropriation of $700,000. More than 800 of the leading exhibitors of the world have applied for extensive space in the exhibit halls. Two thousand applications for concessions have been filed. President Taft has sent a message to Congress asking the United States Government to appropriate $2,000,000 to provide for a suitable exhibit and a building for the Government at the exposition.——Two vouchers for $15,000 each, representing the third and fourth payments on account of the Southern Pacific Company's subscription to the Panama-Pacific Exposition and two of $10,000 each on account of the Central Pacific Railroad's subscription have been received, making a total of $50,000. The total subscription of the Southern Pacific Co. was $250,000.

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Miscellaneous Engineering Construction

San Francisco.—The Blakely Mill Company has reincorporated in the name of the Blakely Mill Corporation. D. E. Skinner, W. J. Hotchkiss, C. A. Mohrhart, W. E. Creed, and John W. Eddy were the trustees signing the petition. The new company owns and controls the interests formerly held by the Blakely Mill Company, including properties that were formerly held by Cyrus Walker. Its timber holdings are said to be the largest in the state of Washington, amounting to approximately 10% of the entire lumber output. The lumber interests of John and C. A. Hooper of San Francisco are said to be in control of the new organization.—The Board of Harbor Commissioners has approved the plans submitted by Jerome Newman, chief engineer, for pier No. 39 to be constructed north of Beach street. The new pier will be 900 ft. long and 140 ft. wide with a double deck shed.—A contract for widening the outer end of Sixteenth street wharf has been awarded to the Healy Tibbitts Construction Company for the sum of $6732.—The Board has awarded a contract to the Pacific Creosoting Company of Seattle for piles at a price of $4220.—Repairs have been authorized to conform with the recommendation of the chief engineer for pier No. 6 at a cost of $3250, pier No. 42 at a cost of $500, and pier No. 44 at a cost of $1000.—The plan of the city engineer for the construction of a sewer across Golden Gate park has been approved by the Board of Public Works. The cost is estimated at $20,000.—The Board will let a contract for the completion of the sewer to be constructed across Golden Gate park at 48th avenue, the Consolidated Construction Co. having abandoned work at this point.

Oakland.—Plans for the new bridge to be erected across 8th street over the lagoon which connects Lake Merritt with the estuary have been submitted to bidders. The estimated cost is $35,000. J. J. Donovan is city supervising architect.

Richmond.—As result of conferences between the city attorney of Richmond and a San Francisco firm of attorneys, the legality of the Richmond harbor bonds has been approved.—The Western Pipe & Steel Co. has received contract for approximately 30 miles of 16-in. diameter irrigation pipe for service in the Sacramento valley.

Marysville. — The Board of Supervisors has awarded contract to the Portland Concrete Pile Co. for the construction of a new bridge of the 3-hinged reinforced concrete arched type at a cost of $38,490.

Oroville. — New bridge spanning the Feather river east of Gridley is completed. The cost is $48,000.

Gridley, Butte County.—A committee of the city trustees consisting of H. C. Veatch, William Brown, and E. Wickman are preparing plans for the construction of a complete new sewer system. Mr. Castner, city engineer of Healdsburg, has charge of the design. Funds will be furnished by the city and no bond issue will be necessary.

Sacramento.—Property owners south of Y street are considering the construction of a levee at Sutterville at their own expense. E. M. Wilder is city commissioner having the matter in hand. The cost will be about $25,000.

Meridian, Sutter County. — Nineteen carloads of steel out of a total of 900 tons for the construction of the new Northern Electric Railway and wagon bridge over the Sacramento river have arrived on the ground. The Thompson Bridge Co. of San Francisco has the contract.

Los Angeles.—The city engineer has been instructed by the Harbor Advisory Board to prepare estimates of cost and the quantity of earth required to fill 146 acres owned by the city at the eastern end of 22nd street, San Pedro. Homer Hamlin is city engineer.—The Board of Public Works has prepared specifications of garbage disposal for bidders.—The report of Mr. Goodrich, consulting engineer for the Harbor Commission, will be ready shortly after the first of January.—The Board of Public Works has granted a five-months' extension of time to the Standard American Dredging Co. to complete its contract for dredging in the west channel, adjacent to municipal dock No. 1 in the outer harbor.—The Dominguez Land Co., of which Ralph Bennett is chief engineer, has turned over the first unit of the $120,000 septic sewer system for the new industrial city of Torrance. Seven miles of sewers has been completed in the new city at a cost of over $50,000. Septic tanks have been completed and also a 7000-ft. outfall pipe.—The Board of Public Works has awarded a contract for creosoted piling for the 670-ft. wharf at Wilmington to the St. Helens Creosoted Piling Co. for the sum of $21,293.25.—The Har-

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bor Advisory Board has decided to build a 670-ft. wharf at the foot of Channel street on force account. A pile driver plant with barges and towboat will be purchased at a cost of $10,000.—Bids will be advertised for the construction of a sanitary and storm sewer in Fries street, Wilmington, the estimated cost of which is about $10,000.—Snare & Friest of New York have put in the lowest bid for the construction of the 2600-ft. concrete wharf to be erected on the side of municipal dock No. 1. The bid amounted to $444,777. They were awarded the contract. The price is $5000 less than the approximate estimate made by the city engineer.—The Eastern American Dredging Co. has begun depositing rock for the riprap work on the east side of the Huntington fill.—The City Council, sitting as members of the tunnel and streets committee, by a unanimous vote has issued a call to the council to instruct the city engineers to prepare immediately plans and specifications for both the First and Second street tunnels. —The city has reported to the Board of Public Works that the north pylon of the Buena Vista bridge is settling out of plumb and the bridge therefore is not safe.

Caldwell, Idaho.—Forbes & Co., bridge contractors of this city, have contracts for 10 steel bridges, three of which will be built in Canyon county across the Fayette river, one at Fruitland, one opposite New Plymouth, and one at Leatha. The total estimated cost is $47,000. One bridge is to be built in Adams county across the little Weiser river at a cost of $15,000. Seven bridges are to be built in Washington county at an aggregate cost of $42,000.

North Yakima, Washington.—Plans for a sewer system to cost $274,000 have been prepared by N. A. Gilman, city engineer. A special bond election to provide funds for this work will be called in February or March.

Washington, D. C.—The Reclamation Service through the Interior Department has recommended to Congress the construction of a bridge for vehicles and foot passengers across the Colorado river at Yuma at a cost of $75,000.

CHARLES C. MOORE & Co., engineers, of San Francisco, will erect a six-story building on the corner of First and Mission streets for their exclusive use. The building will be of steel and reinforced concrete.

Personal

ALFRED STILL is in San Francisco.

DANIEL W. MEAD, of Madison, Wisconsin, is in Seattle.

A. G. BRIGGS, of the Vix Engineering Co., has gone to Corliss, Wisconsin.

WILLIAM BENDEL is in charge of the Oakland, Antioch & Eastern shops at Oakland.

ROBERT HOWES, of Seattle, was in Vancouver, B. C., recently on professional business.

FRANK CORNWELL is in charge of the Central California Traction Co.'s office at Lodi.

C. M. GORDON, of Los Angeles, is attending conference of port authorities at Washington, D. C.

FRED A. FLINDT, field engineer for the Gunn-Thompson Co., has returned to Salt Lake City.

F. BOEKEN has been appointed assistant superintendent of the Geary Street Municipal Railway.

HOWARD T. WALSH has been appointed manager of sales for the Sullivan Machinery Company.

JOHN E. D. TRASK has been appointed chief of the Bureau of Fine Arts for the Panama-Pacific Exposition.

W. D. A. RYAN, of Schenectady, New York, will direct the illumination of the Panama-Pacific Exposition.

ROBERT F. DURYEA has been chosen president of the Associated Civil Engineers of Stanford University.

A. E. BROWN has been appointed trainmaster for the Southern Pacific Co. with headquarters at Sacramento.

Gen. ADNA R. CHAFFEE has resigned his position as a member of the Los Angeles Board of Public Works.

D. G. BEVIS, representing Willett & Burr, of San Francisco, has opened offices at 522 Wall street, Los Angeles.

JOSEPH JACOBS, of Seattle, has finished an investigation and report for an irrigation project on the Columbia river.

F. A. MILLER has been appointed superintendent of power and equipment for the Central California Traction Company.

J. F. RICHARDSON, of the U. S. Reclamation Service, is investigating Carson and Truckee watershed rights at Fallon, Nevada.

H. W. SHERIDAN, of Sacramento, has been

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appointed general superintendent of the Atlantic division of the Southern Pacific Co. with headquarters at New Orleans.

WILBUR FISKE has resigned the chair of the department of geology at Occidental College to become director of the Chaffey Library Foundation.

S. B. WILLIAMSON has resigned his position as engineer for the Pacific division of the Panama canal to become associated with J. G. White & Company.

L. A. NICHOLSON has completed grading and paving for the Park Board at Tacoma, a sewer system at Steilacoom, and a concrete-lined roadway tunnel under the plant of the Tacoma smelter.

C. B. WING was elected president, W. A. CATTELL vice-president, E. T. THURSTON secretary, P. E. HARROUN treasurer of the San Francisco chapter of the American Society of Civil Engineers.

M. J. FALKENBURG, of Falkenburg & Laucks of Seattle, has returned from a trip to Jordan river in British Columbia, in connection with the construction of an Ambursen type reinforced-concrete dam.

Obituary

ROBERT FORSYTH, one of the most widely known marine engineers in the United States, died in San Francisco, December 18, at the age of 66 years. Mr. Forsyth was a native of Dumfries, Scotland, and came to San Francisco as chief engineer of the British steamer *Prince Alfred* in 1870, and left to join the staff of the Pacific Mail S. S. Co. He was assistant superintending engineer in 1876, and resigned this position to become chief engineer of the Risdon Iron Works. He afterward became chief engineer of the Union Iron Works in 1886, and it was during twenty years of service in this capacity and as president, that more than 23 vessels for the United States Navy were constructed, including the famous *Oregon* and *Olympic*, and a large fleet of merchant vessels. Mr. Forsyth retired in 1906 to engage in consulting practice, looking out for the interests of the Pacific Mail and the American-Hawaiian companies. Mr. Forsyth was noted for his sterling honesty and conscientious regard for the ethics of his profession, his death having removed from this sphere one of the few remaining men identified with the creation of shipbuilding on the Pacific Coast.

Catalogues Received

TALBOT BOILER CO., Seattle, Washington. Descriptive of the characteristics and operation of Talbot boilers.

MUNCIE GAS ENGINE & SUPPLY CO., Muncie, Indiana. 'The Muncie Oil Engine.' Description and operation of a new type of crude-oil engine.

SCHUTTE & KOERTING CO., Philadelphia. 'Power Plant Equipment.' Descriptive of steam power-plant accessories manufactured by this company.

HENDRIE & BOLTHOFF MFG. CO., Denver, Colorado. 'Power Irrigation.' Full data concerning the apparatus handled by this company for irrigation and reclamation.

REINFORCED CONCRETE PIPE CO. of San Francisco, Los Angeles, and Portland. General description with engineering data concerning the use and application of its product.

GENERAL ELECTRIC CO., Schenectady, New York. Bulletin 4939, April 1912. Electric hoists. Dealing with the application of electric motors to mine and industrial hoisting problems.

AMERICAN VANADIUM CO., Pittsburg, Pennsylvania. 'American Vanadium Facts,' November 1912. Additional data concerning the application and characteristics of this interesting alloy of steel.

ARMSTRONG CORK CO., Pittsburg, Pennsylvania. 'Nonpareil High-Pressure Coverings.' The application and use of cork as a heat insulator for high-pressure and superheated steam lines, boilers, and breechings.

Commercial Paragraphs

EDWARD M. CHADBOURNE, representing Willett & Burr of San Francisco, is in Eugene, Oregon, arranging for an installation of 'Bitucrete' pavement.

The PACIFIC GEAR & TOOL WORKS, 1035 Folsom street, San Francisco, has added a Heald cylinder grinder to the shop equipment and can now regrind automobile cylinders without the necessity of reboring.

MACARTHUR BROS. CO., of New York and Chicago, contractors, have opened an office at 1001 Chronicle building, San Francisco, in charge of C. C. Tinkler as Western representative. They are patentees of the 'Pedestal' concrete pile.

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